Studies of Free Sugars Intake Related to Dental Caries Among White Ethnic Adults in the UK

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Studies of Free Sugars Intake Related to Dental Caries Among White Ethnic Adults in the UK

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Abstract

Background: Free sugar intake plays a major role in the development of dental caries. Therefore, proper control of free sugar intake through interventions based on a valid behaviour change framework may help in preventing dental caries among adults. The World Health Organization and Public Health England has identified the need to develop interventions to reduce free sugar intake among Adults and children (WHO, 2015; PHE, 2014).

Aim: The overall aim of this PhD thesis is to examine the predictors related to reducing free sugar intake among White ethnic groups in the UK which can help in developing future interventions.

Methods: This PhD research project employs two research method designs: systematic review and a mixed method design. This thesis is divided into four studies. **The first study** is a systematic review of the effect of interventions based on Social Cognition Models (SCMs) on sugar intake in adults, when compared with educational interventions or no intervention. A range of papers were considered: Systematic Reviews with or without Meta Analyses; Randomised Controlled Trials; Controlled Clinical Trials and Before and After studies, of interventions based on Social Cognition Models aimed at dietary intake of sugar in adults. **Sources:** The Cochrane database including: Oral Health Group's Trials Register (2015), MEDLINE (from 1966 to September 2015), EMBASE (from 1980 to September 2015), PsycINFO (from 1966 to September 2015) were searched. On the basis result from the systematic review, **the Second Study which** is a qualitative study, comprising interviews with 27 individuals concerning their sugar intake, highlighting the facilitating factors and barriers to reducing sugar intake. The COM-B model and the Theoretical Domains Framework (Michie et al 2011, 2013) were used to analyse the data, within the analytical approach of Framework theory. On the basis of this analysis, **the third Study** was carried out to develop an online survey of Barriers to and facilitating factors for reducing sugar intakes based on the Theoretical Domains Framework**.** After the online survey was piloted with 20 individuals and modified, **the fourth Study** was carried out which is an online cross-sectional survey of 200 individuals was conducted exploring the relationship between the newly developed

questionnaire measure of barriers to and facilitating factors for sugar intake, and sugar intake as recorded by a Food Frequency Questionnaire.

Results: For the **systematic review,** no studies were located which fulfilled the criteria of the review, highlighting the need to explore the facilitators and barriers to reducing free sugar intake among White ethic groups by using two models of Behaviour Change Wheel system which of the next study. For **the qualitative study**, data saturation occurred at 27 interviews. The COM-B Model and TDF domains captured various factors that may influence the consumption of free sugar. TDF elements which are reflected in the study are: Knowledge; Psychological Skills; Memory, Attention, and Decision Processes; Behavioural Regulation; Physical Skills; Social influence Environmental context and resources Social and professional role and identity; Beliefs about Capabilities; Beliefs about Consequence; Intentions and Goals Reinforcement; and Emotions. COM-B Model elements which are reflected in the study are: Psychological capabilities, Physical capabilities, Social Opportunities, Physical Opportunities, Reflective Motivation, and Automatic Motivation. For **the pilot study**: many changes were made which have improved the validity and reliability of surveyr. For **the quantitative study**, The Majority of the participants were White British (96%) from White English, Scottish, Welsh and British background. Also, majority of the participants young adults aged between 18 and 32 (82 %) and more than a half were females (64.5%) and from King's College London (67.5%). The response rate for the surveyr was very high which was of 97%. Majority of the TDF scales have Cronbach's alpha between excellent at α 0.883 and acceptable at α 0.711. There were statistical differences between the high and low free sugars intakes among White ethnic groups in the follow TDF domains: knowledge, physical skills, social influence, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role and identity (Automatic), and emotions. Also, there were some differences between groups within demograpgic data. There were no significant association between the levels of free sugar intake and the following demographic data: ethnicity, employment, age, gender, Dental Filling Status, Dental Filling History, BMI, Current Health Condition, social classes and districts of living. However, there were significant association between the levels of free sugar intake

and the following demographic data: qualifications and house hold status. There were significant correlations between the following TDF factors and free sugars intake: knowledge, psychological skills, memory attention and decision processes, physical skills, social influences, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role and identity (automatic motivation) and emotions. However, these correlations various between negative and positive relationships. The six predictors are: Environment Context and Resources; Social and Professional Role and Identity (Automatic Motivation); Social and Professional Role and Identity (Reflective Motivation); Reinforcement; Beliefs About Consequences; and Beliefs About Capabilities, however, the predictability between these predictors various. The regression identified model three with three significant predictors among White ethnic participants who have dental fillings. The three predictors are: social and professional role and identity (Automatic Motivation), Environment context and resources and physical skills, however, the predictability between these predictors various. In terms of gender, there were differences between male and female in some of the predictors for free sugars intake. For male the predictors are: environment context and resources; social and professional role and identity (automatic motivation); social and professional role and identity (reflective motivation), and knowledge. For female the predictors are: environment context and resources; social and professional role and identity (automatic motivation); reinforcement; beliefs about consequences and physical skills. Not having dental filling is positively predicted free sugar intake.

Conclusion: For **the systematic review**, there is a need for more clinical trials to assess the effectiveness of interventions based on psychological theory in reducing dietary sugar intake among adults. For **the qualitative study**, the COM-B model and TDF framework provided a comprehensive account of the barriers and facilitators of reducing sugar intake among White ethnic groups. For **the quantitative study**, overall, there were different between high and low free sugar intake in relation to TDF domains. The study identified six predictors are: Environment Context and Resources; Social and Professional Role and Identity (Automatic Motivation); Social and Professional Role and Identity (Reflective Motivation); Reinforcement; Beliefs About Consequences; and Beliefs About Capabilities which can be used to develop interventions to reduce free sugar intake among white ethnic groups.

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1. Introduction:

Free Sugar intake of more than 10% of the total energy intake per day can lead to a high level of dental caries among adults even with exposure to fluoride (Moynihan and Kelly, 2014; Bernabé and Sheiham, 2014a; 2014b; Sheiham and James, 2014; Sheiham and James, 2014; Slade et al, 2013; White et al., 2011; Maru and Narendran, 2012; Vos et al., 2012). In addition to dental caries concerns, high consumption of free sugar intakes causes increase of weight, which is known for high risk of health diseases including type two diabetes, heart disease and stroke (Butland et al, 2007; SACN, 2015). Therefore, the World Health Organisation (2015) published new guidelines recently for free sugar intake in both adults and children and suggested the following recommendations:

- a reduction in free sugar intake during the lifespan of individuals,
- a reduction in free sugar intake to less than 10% of the total energy intake for both adults and children, and
- a conditional recommendation of a further reduction in free sugar intake to less than 5% of the total energy intake in these populations.

A daily free sugar intake of less than 10% of the total energy intake reduces the prevalence of dental caries, and a further reduction in free sugar intake to less than 5% will even further decrease the risk of dental caries (Moynihan and Kelly, 2014; PHE, 2014). In addition, based on ecological studies, free sugar intake of less than 5% of the total energy consumed will also prevent the progression of dental caries long-term (Moynihan and Kelly, 2014). Public Health of England (PHE, 2015) supported and argued the reduction of free sugar intake to 5% of dietary energy to maintain general and oral health condition. Free sugar intake of 5% of the total energy consumed is equivalent to 7-8 teaspoons (35 g) of sugar for men and 5-6 teaspoons (25 g) for women (Limb, 2014). According to Defra report (2014) the White British adults consume more free sugar than the recommended by the WHO (2015) and when compared with other ethnicities in the UK.

Achieving the target consumption of free sugars will require behaviour change by individuals, and the dental team can play an important part in assisting people to achieve this. Theories of behaviour change [Davis et al., 2014; Munro, 2007; Ogden, 2004; Forshaw, 2002] are essential in the design of effective behaviour change

strategies. Interventions based on such models have been shown to be better prediction of behaviour changes than non-theory-based interventions [Abraham et al., 2009]. Social Cognition Models (SCMs) are a subgroup of behaviour change theories, which are based on the assumption that the individuals' attitude and beliefs towards a behaviour are strongly predictive of the likelihood of them engaging in that behaviour (Newton and Asimakopoulou, 2015).

The most commonly used SCMs by the literature; Theory of Planned Behaviour, Information-Motivation-Behavioural-Skills Model, Transtheoretical Model of Change, and Social Cognitive Theory (Davis et al, 2014). While these are the most prevalently used theories, according to Michie and West (2013) they may not be the most effective to capture the full complexity of behaviour change. In a discussion of the weaknesses of the extant literature, Michie, Aktin and West (2014) instead argue that the Behaviour Change Wheel (BCW) system is most comprehensively capture the full range of factors that influence behaviour within the context and suggest solutions to desired behaviours.

This PhD thesis will discuss the application of the Behaviour Change Wheel system in particular COM-B Model and Thermotical Domani Framework to understanding factors and predictors towards reducing free sugar intake among White British adults; in return it can help in the development of intervention trail to reduce free sugar intake as one of the future suggestion researches. The thesis consists of 11 chapters. **Chapter two** discusses the literature related to free sugar intake including health and dental risk of consuming high free sugar intake. Also, it will discuss the benefits of reducing free sugar intake and the prevention actions to reduce free sugar intake. This part of the chapter, the author provides a summary of the latest evidence regarding oral healthcare for adult populations, particularly looking at the role of tooth brushing, interdental cleansing, regular dental attendance, fluoride and in more depth in reducing free sugar intake. This is necessary to clarify the possible benefits and limitations of oral hygiene and free sugar control on dental caries among adults. After that, the chapter discusses the application of psychological models on general and oral health and suggests the possible outcome on reducing free sugar consumption among adults. **Chapters three to five** highlights motivations for the PhD project, aims and objectives and research designs. **Chapter six**, reports on a systematic review of the effect of interventions based on Social Cognition Models (SCMs) on sugar intake in

adults, when compared with educational interventions or no intervention. No studies were located which fulfilled the criteria of the review, highlighting the need for the development of interventions based on psychological models for sugar intake, and their testing in Randomised Controlled Trials. **Chapter seven** reports on a qualitative study, comprising interviews with 27 individuals concerning their sugar intake, highlighting the facilitating factors and barriers to reducing sugar intake. The COM-B model and the Theoretical Domains Framework (Michie et al 2011, 2013) were used to analyse the data, within the analytical approach of Framework theory. On the basis of the qualitative findings related to barriers and facilitators, for reducing sugar intakes based on the Theoretical Domains Framework, an online survey development is reported in **chapter eight**. This chapter report on the process of contextualizing of the online survey. Finally, a cross sectional survey of 200 individuals was conducted exploring the relationship between the newly developed questionnaire measure of barriers to and facilitating factors for sugar intake, and sugar intake as recorded by a Food Frequency Questionnaire. The analysis and the findings of this study is reported in **chapter nine**. Finally, **chapters from 10 to 12** highlight the conclusion, limitations and implications of the findings; also suggests the future trials and other proposed studies and lessoned learnt. Figure one Illustrate the main five sections of PhD thesis and the relation between them.

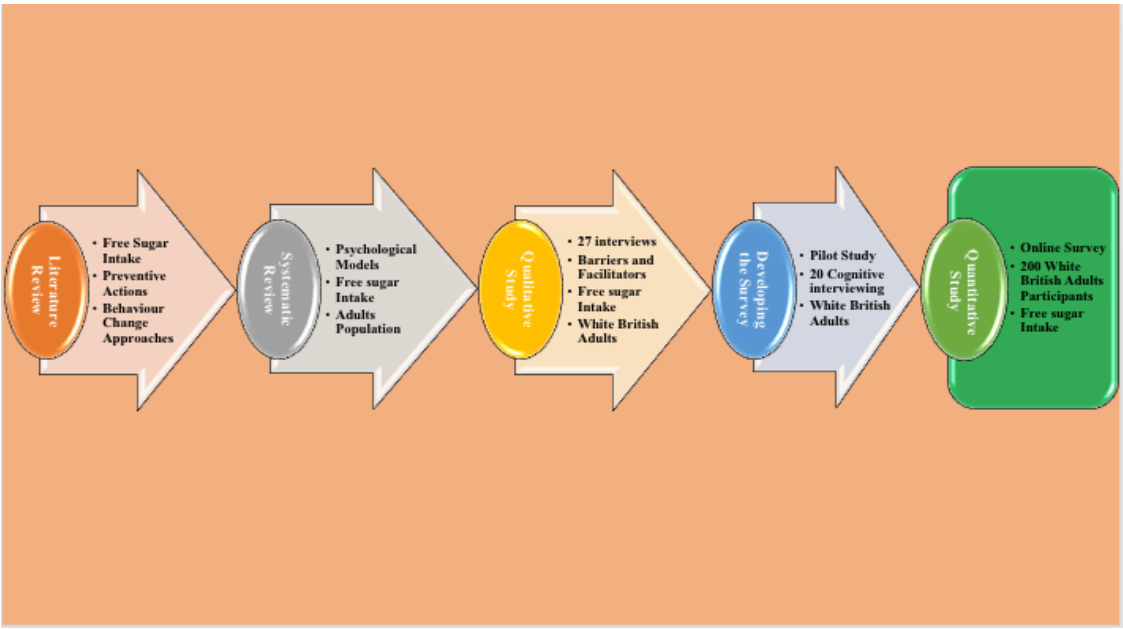

Fig.1. Illustrate the main five sections of PhD thesis and the relation between them

2. Literature Review

2.1. Literature search strategy

The purpose of this literature review of the PhD project is to become familiar with three main areas, including free sugar intake, prevention actions to reduce high intake of free sugar, and psychological models for predicting behaviours related to free sugar intake or interventions based on psychological models that aim to reduce free sugar intake. Knowledge about these three areas ranges from more general information on free sugar intake compared with more focused and comprehensive information about psychological models used to predict behaviours related to free sugar intake or design interventions to reduce free sugar intake. The review assists in identifying the gap in the literature related to this PhD project. Rather than a systematic review, where comprehensive and explicit qualitative and quantitative assessments are made, this is a narrative review of the literature related to the three areas that involve literature of dental and general health. Overall, this literature review highlights whether behaviour change models can be applied as predictors to reduce free sugar intake among White British adults and if they can be used as theory to guide the development of interventions to reduce the intake of free sugar.

Five indexed databases, Medline, PsycINFO, Global Health, Pubmed, and EMBASE, were used for the literature review. The literature search encompassed English language documents only because of the difficulty in translating literature to English and because this was not intended to be a systematic review. Most of the search terms related to this literature review are listed in Table 1.

Table 1. Literature search terms

Topic	Terms
Free sugars intake	added sugars intake OR free sugars intake OR processed sugars OR non-milk extrinsic sugars intake OR sugars OR dietary sugars
Dental caries	dental caries OR tooth decay OR prevalence of dental caries OR dental caries preventions
Oral health	oral health OR dental health OR dental hygiene OR oral hygiene OR oral health prevention OR dental health prevention OR dental health OR dental health prevention OR dental caries prevention OR dental health behaviour OR dental health promotion OR dental health education OR oral health prevention OR oral health behaviour OR periodontal diseases prevention OR oral health promotion OR oral health education OR tooth brushing OR interdental cleansing OR dental floss OR dental attendance OR smoking cessation
General health	health-related behaviours OR health behaviours OR health-related behaviours prevention OR general health behaviour OR general health prevention OR health prevention OR health education OR health promotion OR health behaviour OR healthy lifestyle OR healthy behaviour OR smoking cessation OR exercise OR healthy diet
Psychological models	behaviour change theories OR psychological theories OR social cognition models OR Transtheoretical Model of change (TTM) OR

	stages of change OR Theory of Planned Behaviour (TPB) OR Social Cognitive Theory (SCT) OR Information-Motivation Behavioural Skills (IMB) Model OR PRIME Theory OR PRIME Motivational Theory OR Behaviour Change Wheel (BCW) OR COM-B Model OR Theoretical Domains Framework (TDF) OR Behavioural Change Techniques (BCTs)
Adults	adults OR students university OR adulthood OR young adults OR middle aged adults OR old aged adults
Predictors	predictors
Contributors	factors OR contributor OR facilitators OR barriers OR determinants

This literature review focuses primarily on the research period between January 1947 and February 2017. Saying that, this wasn't the case in the three areas of the literature. Studies reporting on the use of the six psychological models for the prediction of and developing interventions for general and oral health-related behaviour among adults and children younger than 18 years were included.
The researcher focused on different types of studies, including systematic reviews, randomised control trials (RCTs), clinical trials, before and after studies, interventions, and correlations studies, because these varied studies provide relevant information regarding effectiveness of interventions, predictors of behaviour models, and factors related to free sugars intake. Priority was given to systematic reviews if they were relevant to the aim of the literature review because they are the highest quality source of evidence in the hierarchy of evidence (CEBD, 2018). Other types of studies were included when no relevant systematic review could be found or for further assessments of the studies. Narrative reviews in the literature were also used to be comprehensive. No application of the COM-B or TDF for intervention to reduce free sugars intake or to predict behaviours related to reduce free sugars intake could be found in the literature.

2.2. Free sugars intake

2.2.1. Introduction

Free sugars intake plays an important role in this thesis because it contributes to many diseases, including dental caries. Therefore, the first topic to be discussed in the literature review is free sugars intake as it relates to many core elements of the thesis. Key factors considered include the terminology related to sugars and types of cariogenic sugars and dietary starches, the difference between free sugars intake and frequency, reasons for selecting free sugars intake over frequency in analyses, different methods to assess sugars intake, and the health impact of free sugars intake including dental caries and sugars addiction. In addition, factors contributing to free sugars intake and benefits of reducing sugars intake to 5% are discussed in terms of health and economics.

2.2.2. Terminology related to sugars

There are many terminologies related to sugars, which can cause misperceptions (Daly et al., 2013). Consequently, this section is provided to discuss the differences between these terms and highlight the terms that were used in this PhD project.

The term "***sugars***" refers to "monosaccharides and disaccharides" (SACN, 2015; p.17), which includes intrinsic sugars, extrinsic milk sugars, and non-milk extrinsic sugars (NMES) (WHO, 2015).

The term "***intrinsic sugars***" refers to the natural presentation of sugars molecules inside the structure of foods; for example, fresh vegetables and fruits (Daly et al., 2013; SACN, 2015). In contrast, the term "***extrinsic milk sugars***" refers to the natural presentation of sugars molecules outside the structure of foods; for examples, milks and milk products (Daly et al., 2013; SACN, 2015). The term "***non-milk extrinsic sugars (NMES)***", which is similar to the term "***free sugars***", refers to *"monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates"* (WHO, 2015; p.1). However, there is a slight difference between the two terms of sugars; that is, NMES also include 50% fruit sugars from canned and dried fruits (Bates et al., 2014). The term "***added sugars***" refers to *"sugars or syrups added to foods and drinks by the manufacturer, cook or*

consumer, plus sugars present in honey, syrups, fruit juices and fruit concentrates. It does not include sugars found in whole fresh fruit and vegetables and those naturally present in milk and milk products" (Public Health of England [PHE], 2014a; p.32). These sugars include brown, white, and raw sugars (Sheiham and James, 2015). The term "***total sugars***" refers to added sugars and naturally presented sugars in foods (The European Food Safety Authority cited in SACN, 2015). The final term related to sugars is ***fermentable carbohydrate. Fermentable carbohydrate***s are "free sugars, glucose polymers, fermentable oligosaccharides, and highly refined starches" (Sheiham and James, 2015; p.1342). Ironically, fermentable carbohydrates are not fermentable by cariogenic bacteria (Sheiham and James, 2015). The term that is used in this thesis is "free sugars" because many studies report about the effect of free sugars on caries and no side effects consuming intrinsic sugars or extrinsic sugars in milk have been reported (WHO, 2015).

2.2.3. Types of cariogenic sugars

The most cariogenic sugars is sucrose, which is known as the "archcriminal". These designations stem from the fact that sucrose is fermentable in the oral cavity by cariogenic bacteria and it acts as an essential mechanism for intracellular and extracellular polysaccharides formation in dental plaque (Gupta et al., 2013; Sheiham and James, 2015). In contrast, lactose is the least harmful sugars. This designation is based on studies conducted on animals (Gupta et al., 2013). Fructose and glucose have been shown to be more cariogenic than lactose (Gupta et al., 2013). All types of sugars can cause caries, but the rapidity and severity of caries development varies among them.

2.2.4. Dietary starches and caries: is there any relation?

Contradicting findings have been reported in the literature regarding the relationship between dietary starches and dental caries (Sheiham and James, 2015). For instance, although longitudinal studies of both Campain et al., (2003) and Chankanka et al. (2011) found a positive relationship between dietary starches and dental caries, Marshall and his colleagues (2005) found no relationship between starches and caries in similar studies. The findings of Marshall et al. are supported by a recent comprehensive review by the

Scientific Advisory Committee on Nutrition (SACN) in which they concluded there is a lack of evidence to support a relationship between caries and dietary starches (SACN, 2015). Nonetheless, under conditions in which sugars are present in starchy foods, a positive relation can be found (Rugg-Gunn, 1993).

2.2.5. Free sugars intake versus frequency

The topic of the importance of frequency versus amount intake of sugary food is debatable. Some suggest that sugary food intake plays a major role in caries progression (Moynihan and Kelly, 2014; Sheiham and James, 2014). Others emphasize the frequency more than intake (Cottrell, 2014; European Food Safety Authority, 2010). The argument of a correlation between frequency of sugars intake and dental caries is based on animal experimen studies (Konig, Schmid, and Schmid, 1968) and some epidemiological studies like the Vipeholm Dental Caries Study (Gustafsson et al., 1954). However, the nature the feeding habits of animals are not as complex as human. Also, the Vipeholm Dental Caries Study has subjects who were mentally deficient patients with poor oral hygiene who do not represent the general population. Moreover, some of these studies do not require reporting daily frequency and intake of free sugars in their questionnaire, which is essential for meaningful results (Moynihan, 2017). Some authors argue that there is a strong association between these two factors; that is, decreasing the frequency of sugars intake will help decrease the intake amount and vice versa (Rugg-Gunn et al., 1984; WHO, 1991; Gupta et al., 2013).

The World Health Organization report (WHO, 2003) indicates that frequency and intake of sugars are important factors to consider in the prevention of related chronic diseases. This common risk factor approach would help to prevent dental caries and other systemics is easy to monitor and assess against quantitative indictors (Moynihan, 2016). In contrast, the SACN found that there are limited studies that assess the frequency of free sugars intake and the relationship between frequency intake of free sugars and dental caries, so no association between the two variables could be determined (SACN, 2015). These findings do not indicate that the limitation of frequency of free sugar intake should be disregarded, rather the findings encourage further studies with more comprehensive criteria to assess the relationship between the frequency of free sugars intake and increases in dental. Also, reducing the

frequency of free sugars intake would be useful dental health advice at an individual level in a clinical setting (Moynihan, 2016). Focusing only on frequency of free sugars intake, however, will not have an effect on reducing the occurrence of other diseases associated with free sugars intake (Moynihan, 2017). Based on the results in the SACN review (SACN 2015), this PhD research focused on tackling the issue of free sugars intake rather than frequency.

2.2.6. General health and free sugars intake

The unrestricted intake of free sugars is associated with many risks in general health. The SACN in the UK conducted a vigorous review to identify the relationship between general health and dietary sugars (SACN, 2015). The committee included prospective cohort studies and randomized controlled trials since 20 years ago. The review reveals the following findings in relation to free sugars intake:

- Based on prospective cohort studies, evidence shows that the risk of type 2 diabetes mellitus is associated with the high consumption of sugar-sweetened drinks (SSDs). In addition, the prospective studies show that the intake of sugars and SSDs are not related to colorectal cancer, and there is insufficient evidence to verify an association between cardiovascular disease risk factors. Also, a recent systematic review identified that there is no association between sucrose intake and the breast, pancreas, and endometrial cancers (Bartrina and Rodrigo, 2013).
- Based on randomized controlled trials, the evidence suggests that the intake of SSDs compared with low-calorie drinks results in greater weight gain and increments of body mass index (BMI) among children, adolescents, and adults because of high energy consumption (SACN, 2015). Also, these studies show that the increment of free sugars intake percentage from the total energy leads to the increase consumption of energy intake in adults. These results are supported by many epidemiological studies (Evans, 2017).
- A recently longitudinal cohort study examined the relation between incidence of common mental illnesses and sugars intake from sweet food and beverages (Knüppel et al., 2017). The study covered period from 1983 to 2013, and involved a total of 7000 women and men. The study results suggest that high consumption of sweet foods and drinks has a high chance of negatively

affecting mental health in the long term. For instance, the study found that depression is high among men and women who have high free sugars intake and mood disorders. Other evidence shows the side effect of high intake of free sugars in the long term, but more evidence is need to support their claims.

Taking these study results into consideration, the SACN highly recommends that the intake of free sugars should be less than 5% of the total energy intake. The rationale for the less than 5% is discussed in diet control section of the SACN report (SACN, 2015). This PhD project focused on facilitating the application of the SACN recommendation to reduce free sugars intake among adults. Ultimately, this approach could help in reducing type 2 diabetes mellitus, obesity, high consumption of energy intake, and possibly mental health in adults.

2.2.7. Dental caries and free sugars intake

Dental caries is a prevalent issue that affects the majority of the adult population around the world (White et al., 2011; Maru and Narendran, 2012; Vos et al., 2012). In the United States, more than 84% of adults have had some caries experience (NIDCR, 2014) and the average DMFT (diseased, missing, filled teeth) score of adults (aged 35–44 years) in the UK is 11.57 (Bernabé and Sheiham, 2014a; 2014b). Also, Bernabé and Sheiham (2014a; 2014b) found that dental caries are high in adults compared with children and increase by age in many countries. The severity of dental caries among adults is illustrated in Figures 2 and 3. In addition, based on a WHO (2012) report, dental caries affects 60–90% of children and almost 100% of adults. Yet dental caries is preventable through the application of appropriate plaque control methods and diet control, including reducing the intake and frequency of free sugars to mealtimes and no more than four times per day (PHE, 2014; Moynihan and Kelly, 2014). The SACN in the UK conducted a vigorous review to identify the relationship between dental health and dietary sugars (SACN, 2015) and revealed cohort studies showing that the high risk of dental caries in deciduous and permanent teeth is associated with high intake of free sugars and sugar-containing drinks and diets.

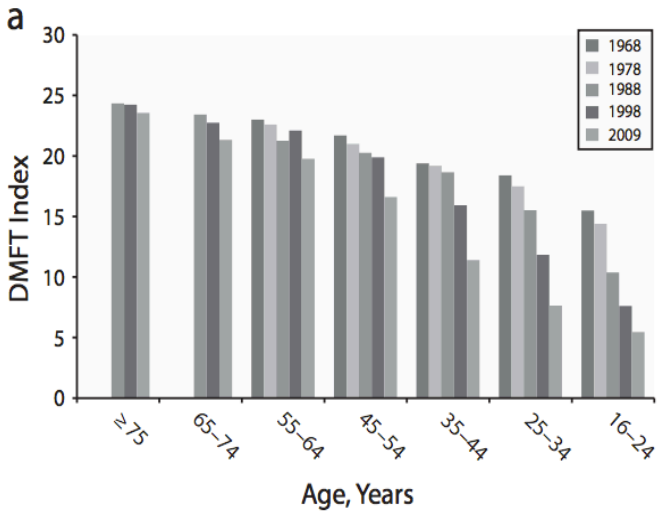

Fig. 2. Trends in number of decayed, missing, and filled teeth (DMFT index) by age and years in England and Wales (adapted from Bernabé and Sheiham, 2014a; p.e3).

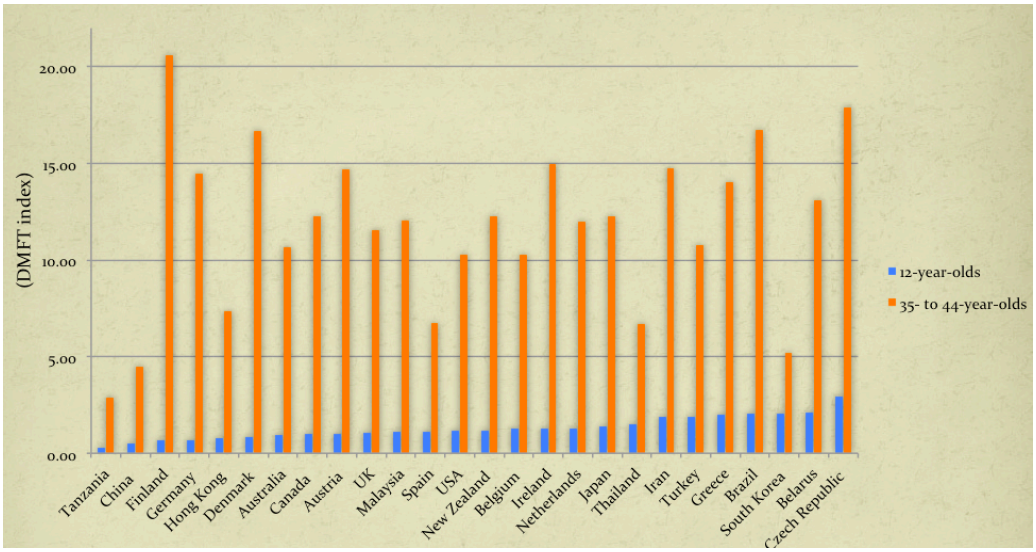

Fig. 3. National estimates for DMFT (decayed, missing, filled teeth) index for 12-year-olds, and 35–44-year-olds in 26 countries (adapted from Bernabé and Sheiham, 2014b; p.3).

In line with this finding, Moynihan and Kelly (2014) conducted an extensive systematic review and identified that consuming daily free sugars intake to more than 10% of total energy increases the prevalence of dental caries in the long-term. Therefore, Sheiham and James (2015; p.1345) have scientifically argued that dental caries is a "*diet-mediated disease*" rather than an infectious, transmissible, and multi-factorial disease. The main justification for this definition is dental caries will not form without the presence of sugar, which leads to the production of acid by certain

bacteria and the formation of caries (Sheiham and James, 2015).

Recently scientists have defined dental caries as *"a biofilm-mediated, sugar-driven, multifactorial, dynamic disease that results in the phasic demineralization and remineralization of dental hard tissues"* (Pitts et al., 2017; p.1). In addition, others consider it an infection, transmissible from parents or caregiver to their children (Ritter, Eidson, and Donovan, 2013). The rationale behind this definition is the involvement of many and complex factors in the development of the disease, including free sugars, oral microorganisms, salivary flow, application of fluoride, free sugars frequency, and teeth surfaces (Sheiham and James, 2015).

According to the definition of dental caries, there are four major factors that play a role dental caries formation, including free sugars, tooth substrate, acidogenic bacteria, and time (Quock, 2015). The first and crucial factor is free sugars, which acts as a main source for acid production by the bacteria (Ritter, Eidson, and Donovan, 2013). This acid causes dissolution of the minerals within the first two layers of the tooth structure (Ritter, Eidson, and Donovan, 2013). The acid also acts as asource of energy for acidogenic bacteria (Ritter, Eidson, and Donovan, 2013). The second factor is acidogenic bacteria, which are various bacteria species involved in the fermentation of free sugars and formation of acid (Simon-Soro and Mira, 2015). It is estimated that between 40 and 160 types of bacteria are involved in caries formation; good examples of these species are *Veillonella, Streptococcus, and Selenomonas* (Simon-Soro et al., 2014). The third factor is tooth surfaces, where minerals are dissolved by acid and caries lesions are formed (Quock, 2015). The fourth factor is time, which is exposure duration of tooth surfaces to acid (Quock, 2015). The longer the tooth surfaces are exposed to acid, the more minerals will be dissolved from tooth surface, which will in turn lead to caries lesions (Quock, 2015).

In addition to the above factors, there are risks factors that have potential roles in the formation of dental caries. These risk factors include salivary flow, application of fluoride, oral hygiene practice, and frequency and intake of sugary food (Ritter, Eidson, and Donovan, 2013; Gupta et al., 2013). Poor saliva flow and buffering and insufficient oral hygiene practice, including the use of fluoride toothpaste, can potentially accelerate the formation of dental caries (Ritter, Eidson, and Donovan, 2013).

From the above evidence, it is very evident that free sugars intake plays an important role in the development of dental caries. Therefore, Moynihan and Kelly (2014), WHO (WHO, 2015), and PHE (PHE, 2015) made a strong recommendation that reducing consumption of daily free sugars intake to less than 10% of total energy would decrease the prevalence of dental caries and a further reduction to less than 5% may prevent the progression of dental caries in the long-term. Other factors accelerate the cariogenic properties of free sugars (Sheiham and James, 2015). Overall, this evidence indicates it is particularly important to pay attention to the disease in adults and plan means to reduce their consumption of free sugars. This emphasis does not mean to stop targeting children prevention programs, rather to extend such programs further to adults.

2.2.8. Addiction and free sugars intake

Food addiction theory stresses that free sugars can have the same neurobiological effect as substance addiction when it is excessively consumed (Westwater, Fletcher, and Ziauddeen, 2016). Given this food addiction theory and the high level of consumption of the abundant food stuffs that contain high levels of artificial or refined free sugars on the market, free sugars have addictive potential (Gearhardt, Roberts, and Ashe, 2013). Many studies have proven that free sugars are addictive substances in animals (Adams et al., 2015; Colantuoni et al., 2001; Le Merrer and Stephens,2006). In contrast, there is lack of evidence in human studies (Westwater, Fletcher, and Ziauddeen, 2016; DiNicolantonio, O'Keefe, and Wilson, 2017; Blundell, Coe, and Hooper, 2014). Hebebrand et al. (2014) claimed there is no strong evidence to support food addiction theory and argued that the available evidence supports the notion of an "eating addiction" which is behavioural (not a food) addiction. However, a recently conducted systematic review (Gordon et al., 2018) that examined 35 studies related to constructs of food addiction in humans and animals shows that foods with added sweetener (e.g., sugar) and fat have a high level of addictive potential. These findings seem to support the food addictive theory. But many of the studies reviewed were conducted in animals (29 studies) and only two clinical trials had control and intervention groups. Furthermore, the animal-feeding process is not as complex an eating behaviour as human (Blundell, Coe, and Hooper, 2014). Based on the currently available evidence, it is not very clear that free sugars intake poses a risk of addiction, so further comprehensive studied are needed.

2.2.9. Prevalence of free sugars intake

The level of free sugars intake among adults in the UK is higher than the recommendation by WHO (2015) and PHE (2015). The free sugars intake among adults ages 19–64 years is 12.1% of the total energy intake and adults over 65 years is 11.5% of the total energy intake based on the recent UK National Diet and Nutrition survey (Bates et al, 2014). In addition, most of ethnic groups in the UK exceeded the less than 5% of free sugars intake recommendation. However, as shown in Figure 4, the reports of the Department for Environment, Food, and Rural Affairs (Defra) indicate that the White ethnic group had the highest free sugars intake between 2011 and 2013 (Department for Environment, 2014a; 2014b; 2015a; 2015b; 2017a; and 2017b; Leung and Stanner, 2011). The term "Free Sugars" include NMES, added sugars, and natural sugars (Scientific Advisory Committee on Nutrition, 2015; PHE, 2015). These free sugars are associated with the formation of dental caries (NOO, 2012). Based on the three major reasons, there is a need to direct more oral health care interventions toward adult populations.

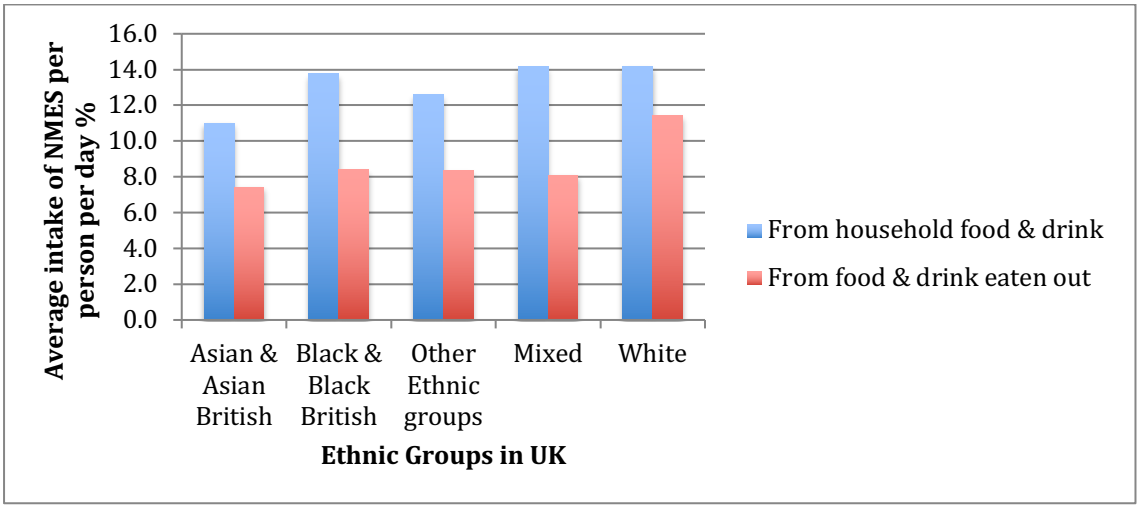

Fig. 4. A three-year average intake of free sugars among five major ethnic groups in the UK (adapted from Defra 2014a,b)

2.2.10. Benefits of reducing free sugars intake to 5%

2.2.10.1. Health

As discussed in the previous sections, high consumption of free sugars leads to a number of major health issues. Therefore, reducing the intake of free sugars to 5% of the total energy would indeed reduce and prevent the burden of such things as obesity and its consequences and dental caries.

2.2.10.2. Economics

Indeed the economic burden of unhealthy eating, including consuming high amounts of free sugars, is very costly worldwide; for example, unhealthy eating in the UK cost the government £5.8–6 billion (Candari, Cylus, and Nolte, 2017). Therefore, reducing the intake of free sugars to 5% is important for the economics of the UK. The estimated total cost saving of the National Health Service (NHS) would be (£576m) within 5 years (PHE, 2015). This saving cost is part of the healthcare of dental caries and comorbidities of obesity.

2.2.11. Factors and predictors of free sugars intake

2.2.11.1. Factors contributing to the consumption of free sugars

There are different four broad factors that contribute to high free sugars intake among adults in the UK, including *environmental, socioeconomic, individual, and social factors*. , Many studies have identified different elements pertaining to the environmental factor. One of these elements is the *sources of free sugars intake*, which refers to the many foods and drinks on the market that contain higher free sugars content than the recommendation (PHE, 2015). There are approximately ten main sources of free sugars intake for adults ages 19–64 years. Seven of these are the main sources of high free sugars intake, including table sugars, biscuits, buns, cakes, pastries, puddings, and soft drinks (PHE, 2015). Another element is limited access to healthy food. Students at the University of North Carolina expressed the feeling that limited access to healthy food made them consume higher amounts of sugary beverages (Stankevitz et al., 2017). The findings of this study are consistent with those of another study involving students in Sydney, Australia, who stated that readily available sugary drinks made them consume high levels of free sugars (Hattersley et al, 2009). The same study found that the quality of the food, including taste and free sugars, is also an impetus to consume sugary drinks.

Advertisements have also been shown to influence free sugars intake. A systematic review (Dıaz-Ramırez et al., 2013) showed that most foods advertised on TV are unhealthy and contain high amounts of fat and free sugars. The study also found that there is a positive relationship between the frequency of advertisements on TV and the consumption of sugary foods by mothers and their children. This result indicates that advertisements influence individuals' choices regarding eating healthy food.

Other elements within the environment are *promotions and pricing of unhealthy food and purchase of unhealthy food* like fast food (Hattersley et al., 2009; Nicklas et al., 2013). For instance, students at the university in Sydney stated that special pricing and promotions on high caloric beverages and purchasing fatty food were contributors to their consumption of high caloric soft drinks that contain free sugars (Hattersley et al., 2009).

Another factor that contributes to high free sugars intake is related to the *socioeconomic status* of the individual. According to National Diet and Nutrition Survey in the UK (Bates et al., 2014), adults with lower incomes consume higher amounts of free sugars, including sugary drinks, than do those with higher income. Similarly, a cohort study of 9991 adults aged 30–64 years showed that individuals with lower income (<£20000/year) consumed more sugar-sweetened beverages than those with higher income (> £40000/year) (Barrett et al., 2017).

There are different aspects of the *individual level* factor that can influence the intake of free sugars. In the aforementioned cohort study of 9991 adults, participants with lower *educational qualifications* (e.g., finished studies at early age and attained no further education) were associated with consuming more sugar-sweetened and artificial sugar-sweetened beverages than participants with further education (Barrett et al., 2017). The study also found that *skipping breakfast* and *inactive behaviours*, like watching television, were among the behaviors that contribute to consumption of sugar-sweetened beverages. A study by Hobbs et al. (2015) corroborates the finding that inactive behaviours wcontribute to free sugars consumption. In their systematic review, young adult participants were shown to have greater consumption of sugary snacks and beverages and less intake of fruits while watching TV. *Knowledge* is also an individual factor that is associated with the risk of increase free sugar intake (Nicklas et al., 2013). In a qualitative interview study of pregnant women (Graham et al., 2013), the participants indicated that they needed to compromise energy for their health because of their pregnancy. Associated factors revealed in this study include *expectations and physical symptoms* (e.g., stomach upset).

Other individual factors that contribute to the consumption of high sugary drinks and food are the *love or the like* of sweet taste and *feelings of rewards and treats*

(Hattersley et al., 2009; Nicklas et al., 2013; Gupta et al., 2018). The *consequence and capability beliefs* of an individual also play a role in the consumption of free sugars (Hattersley et al., 2009; Stankevitz et al., 2017). For instance, in a qualitative interview, students stated that one of the influences in consuming free sugars is the belief regarding its consequence (Hattersley et al., 2009). Students who believed free sugars is unhealthy, drank juice instead of a sugary beverage. Other students who believed sugary beverages increase energy, consumed more (Hattersley et al., 2009). Similar findings were noted in relation to belief about capability to control consuming free sugars intake in a study by Stankevitz et al. (2017). Participants reported that one of the barriers to healthy eating is lack of self-control; that is, the individual cannot avoiding consuming high sugary drinks, which leads to unhealthy eating patterns (Stankevitz et al., 2017). Beliefs that a healthy behaviour can be practiced when compensating for an unhealthy behaviour, known as Compensatory Health Beliefs (CHBs), are common among individuals who aim to eat fewer unhealthy snacks (Amrein et al., 2017). *Readiness for change* is another individual factor that influences intake of free sugars (Hattersley et al., 2009). For example, individuals will reduce free sugars intake if they are ready to reduce the consumption and have the ability to act. Also, individual food choices are controlled mostly through *habits* (which are difficult to change) and *automatic actions or thoughts*, resulting in *limited self-control* over the eating habits (Wansink and Sobal, 2007; Nicklas et al., 2013). Nicklas et al. (2013) also reported that *lack of preparation skills for meals* was one of the barriers to following low free sugars intake. Overall, these studies confirm that there are many factors at the individual level that should be considered before developing any interventions.

The *social influence* factor can also affect adults' consumption of free sugars. For example, a recent systematic review identified that the attitude of one's peers can influence an adult's attitude towards free sugars intake (Gupta et al., 2018). Peer influence is more common and strong during social pressure and relationship periods, whereas parental influence through modeling and avoiding some foods is more constant while growing up (Guidetti & Cavazza, 2010). Similar findings were found in another systematic review; specifically, the influence of social norms in shaping food intake among young adults (Stok et al., 2016) and through socialization with friends and family (Hattersley et al., 2009)

There is evidence, that *gender* plays a role in consumption of free sugars intake. In a cohort study of 9991 adults, men consumed more high sugar-sweetened beverages than women (Barrett et al, 2017). The finding of this study is consistent with another qualitative in-depth interview of university students aged 18–30 years in which female participants were more health conscious than males with regard to the consumption of beverages (Hattersley et al., 2009).

There is evidence that *age* plays a role in free sugars intake. In a cohort study of 9991 adults, younger adults consumed higher sugar-sweetened beverages and artificial sugar-sweetened beverages than older adults (Barrett et al., 2017)

There are different factors that contribute to free sugars intake and the degree of influence varies; importantly knowledge is not always the key for reducing free sugars intake if the environment does not support. For instance, an individual has a good knowledge about reducing free sugars intake, however he/ she cannot reduce high intake of free sugars because of limited budgets and access to cheap sugary food.

2.2.11.2. Predicting free sugars intake

Predicting free sugars intake can add to the understanding of the variation in factors that contribute to health. Predicting free sugars intake can also help in designing behavioural change interventions (Conner and Norman, 2015). Few studies have focused purely on free sugars intake among adults. Astrøm and Okullo (2004) used Theory of Planned Behaviour (TPB) to identify predictors of free sugars intake among Ugandan adolescents in a prospective study of two time intervals. They found that intention for free sugars intake was predicted by perceived behavioural control (19% of the variance) and attitudes (58% of the variance) at the two points in time. Also, they found that intention at time 1 significantly predicted self-perceived free sugars intake at time 2. Moreover, they found that adolescents with high dental caries experience had weak intentions to consume free sugars. These results indicate that dental caries experience can act as facilitator to reduce free sugars intake. Kvaavik et al. (2005) also used TPB constructs and demographic data to identify predictors for

different eating behaviours, included added sugars intake, among 25-year-old men and women. The data collection was at two time points, 1991 and 1999, in Oslo. The researchers found a difference between men and women in relation to the prediction of added sugars. Initially, the TPB indicated that social norms were significant predictors of free sugars intake for women, In the final prediction model, however, past experience behaviour was the only predictor for free sugars intake by women. In contrast, the predictive factors for men's free sugars intake were household income and perceived social norms, indicating there are differences in free sugars intake predictors among men and women. Furthermore, TPB could not capture the other predictors out of its construct, which indicates its limitation in measuring the big picture of predictors of free sugars intake. Overall, these observations suggest that not all intervention development should be at a population level, but there should be an individual level to meet the desired needs of the individuals and a better intervention outcome.

Other studies identified the limitation of using social cognitive theories in accounting for the numerous factors that contribute to free sugars intake (van der Horst et al., 2007; Tak et al., 2011). Hagger et al. (2017) used a more complex model that is derived from multiple theories, including the integrated dual-process and dual-phase models. The model has 10 constructs grouped into four groups; namely, reflective (autonomous and controlled motivation, intentions, attitudes, subjective norm, perceived behavioural control), impulsive (implicit attitudes), volitional (action and coping planning), and behavioural (past free sugars consumption). Hagger and co-workers tested the predictability of the model for free sugars intake among students (mean age of 22 years) from two universities in Australia. They found that intentions towards less free sugars intake significantly predict free sugars consumption through implicit attitudes toward free sugars, the reflective process of action, and impulsive processes. Moreover, they found that autonomous motives, attitude, and subjective norms indirectly predicted intentions. Autonomous motivation significantly affected free sugars intake indirectly through attitude, subjective norm, and perceived behavioural control and intentions. Unlike controlled motivation and perceived behavioural control, there was no effect on free sugars intake. Also, they found intentions predicted coping planning and action planning, but there was no relation effect between intention and action intention on free sugars

intake. Finally, they reported that past experience of free sugars intake is strongly correlated with free sugars intake and explained almost 50% of the variance in free sugars intake. The study indicated may predictors of less free sugars consumption, however the integrated dual-process, dual-phase model didn't consider other factors, including social and environmental factors that have been shown to have influence on free sugars intake. There is a need for more studies that account for more factors to make a more effective prediction of free sugars intake, which can then contribute to better intervention design to reduce free sugars intake.

2.2.12. Assessments of free sugars intake

There are different means to assess free sugars intake including self-reported methods (e.g., food frequency questionnaires), biomarkers (e.g., urine), and clinical indicators (National Obesity Observatory, 2010). Self-reported methods (11 methods) include reports that are completed by the individuals about their food intake; for examples, Food Frequency Questionnaires, 24 Recall, and Short Form Food Frequency Questionnaire (National Obesity Observatory, 2010). The methods vary in their purpose; that is, some are designed to assess consumption of fruits and vegetables and others are designed to assess food intake for children. Self-reporting methods are widely applied in food intake collection because they are inexpensive, easy to administer, and do not require many resources like biomarkers (Kipnis et al., 2002). The main disadvantage of using self-report methods is the bias of recall and psychological characteristics of individuals (National Obesity Observatory, 2010).

Biomarkers are indicators, which can be assessed in blood, bodily fluids, biochemical body tissues, or excreta, provide an indication of a limited number and range of nutrient levels. Clinical indicators are clinical examinations that can identify insufficiencies in nutrients from the physical body appearance. Both indicators are expensive and require many resources, so they could be impractical in some situations like public health cases (National Obesity Observatory, 2010).

Food Frequency Questionnaires (FFQ) were used in this PhD project because they are inexpensive and do not required additional resources. Further details of the FFQ are explained in chapter nine.

2.3. *Preventive actions*

Different preventive actions that are applied to prevent the risk of high free sugars intake and minimize the intake of free sugars are discussed in this section. The first subsection focuses on different oral health actions that could help to prevent dental caries. Oral health education is discussed in the section on methods of behavioural change. The second subsection describes different general health actions that are suggested by Public Health of England (PHE, 2015) to minimize the intake of free sugars.

2.3.1. Oral health actions

The main focus of this section is home-based preventions related to dental caries among adults. Information primarily from the past decade of research is used, and more value is placed on systematic reviews and RCTs than on observational and survey studies.

2.3.1.1. Tooth brushing with fluoridated toothpaste

The single most commonly applied dental hygiene practice by individuals in the world is tooth brushing with fluoride toothpaste. In the UK alone, 75% of individuals claim to brush their teeth with toothpaste at least twice per day and an additional 23% report brushing at least once per day, making it the most common dental practice (White et al., 2011). The next most prevalent methods of dental hygiene maintenance the use of mouthwash, reported at a rate of 31%, and the use of dental floss, reported at a rate of 21% (White et al., 2011). The high prevalence of tooth brushing is likely because tooth brushing with fluoridated toothpaste is easily accessible and affordable and there is a strong evidence base that supports that belief that tooth brushing helps to minimize dental caries (Marinho et al., 2003a, 2003b). Systematic reviews, which are considered to be the highest level of evidence (Avaeyard and Sharp, 2009), and RCTs consistently support that brushing teeth with fluoridated toothpaste is the best home-based mechanism to prevent the progression of dental caries (Kay, 2000).

There are six important considerations when advising patients about tooth brushing; namely, the use of toothpaste, the frequency and duration of brushing, post-brushing rinsing, the type of toothbrush, the toothbrush head, and the brushing technique. The use of toothpaste, frequency of brushing, and post-brushing rinsing all have a direct influence on caries because these three elements are associated with the application of

fluoridated toothpaste (Cury and Tenuta, 2014). It is important to note that brushing the teeth without the use of fluoridated toothpaste will not lead to remineralisation or control acidity production, which leads to caries.

2.3.1.2. Application of fluoridated toothpaste

Brushing teeth with fluoridated toothpaste decreases the demineralization process through the control of acidity produced by biofilm plaque on the tooth surfaces (Cury and Tenuta, 2014). Consequently, this reinforces the process of remineralisation on tooth surfaces. This significant effect of fluoridated toothpaste is noticeable at fluoride concentrations of ≥1000 ppm (Walsh et al., 2010). Therefore, adults are encouraged to use toothpaste containing between 1350 and 1500 ppm of fluoride as this concentration is the most effective in preventing dental caries (PHE, UK, 2014a; Cury and Tenuta, 2014). High-risk adults with active caries or erosion-prone teeth and elderly adults are advised to use a fluoridated toothpaste containing a higher concentration (2800 or 5000 ppm) of fluoride (Nordström and Birkhed, 2010; Ekstrand et al., 2013; PHE, UK, 2014a). There are many advantages of using toothpaste with 5000 ppm fluoride (Ekstrand, 2016). This concentration of fluoride notably decreases the number of gathered plaque, including *mutans streptococci* and *lactobacilli*, and possibily increases the deposition of calcium fluoride on tooth surface more than toothpastes with 1350 and 1500 ppm of fluoride (Ekstrand, 2016). This high-fluoride toothpaste can only be obtained with a prescription because the level is too high for the average user and can cause fluoride toxicity if used inappropriately. The PHE guidelines (2014a) recommend that the amount of toothpaste used by an individual should be sufficient to cover the whole head of a toothbrush.

Many systematic reviews and RCTs have been conducted to assess the effectiveness of fluoride toothpaste in the prevention of dental caries. The systematic reviews show that fluoridated toothpaste, in combination with tooth brushing, reduces dental caries (Twetman et al., 2003; Marinho et al., 2003a, 2003b, 2004; Marinho, 2009; Wright et al., 2014). Based on the systematic reviews, the average prevention of dental caries from fluoridated toothpaste is 24% (95% CI, 21%–28%), and this value increases with an increase of fluoride level in the toothpaste (Marinho, 2009). Unfortunately, all of these systematic reviews focus on children and adolescents rather than adults. One

possible explanation could be that researchers may assume that if fluoridated toothpaste is effective in children and adolescents, then it must also be effective in adults. For instance, Rodrigues and his team (2011) stated that fluoride would not act differently in children than in adults. However, such an assumption requires further support. In contrast, the assumption that there is a difference in action is more probable because observational studies have shown that caries progression varies with age; that is, caries progression in children takes less time than that in adolescents, and adolescent caries progression takes less time than that in adults (Sheiham, 1977). If the process of demineralization in the tooth surface varies between children and adults, the same should be true for the remineralisation process that is enabled by fluoridated toothpaste. Furthermore, the limited number of studies that assessed the effect of fluoridated toothpaste in reducing dental caries among adults were biased (Griffin et al, 2007) and there were limited numbers of well-designed RCTs (Richards, 2009). Therefore, the empirical question of how and under what circumstances fluoridated toothpaste is most effective for adults remains inadequately addressed.

A systematic review assessing the effectiveness of adding triclosan and co-polymer to fluoridated toothpastes in participants with different oral health conditions, including dental caries, produced high quality evidence but showed that the increase in effectiveness in reducing coronal dental caries compared with fluoride alone is small (5%) (Riley and Lamont, 2013). Because the benefit of adding of triclosan and co-polymer to fluoridated toothpaste is not highly significant when compared with the effects of fluoridated toothpaste alone, the PHE guidelines (2014a) do not recommend the use of the triclosan and co-polymer fluoridated toothpastes.

It is evident that the wide application of fluoridated toothpastes has significantly decreased dental caries among children, but dental caries in adults is still high (Bernabé and Sheiham, 2014a,b). This situation means that in addition to fluoride application, there is a need to direct more interventions towards reducing free sugars intake among adults, which is the main cause of dental caries.

2.3.1.3. Frequency of tooth brushing

High frequency of tooth brushing is an important factor in the beneficial application of fluoridated toothpaste because it enhances the treatment effect of fluoridated toothpaste on caries (Marinho, 2009). Therefore, it is recommended that teeth be brushed at least twice per day, at night before bedtime and on one other occasion (PHE, UK, 2014a; SIGN, 2014). Teeth should be brushed at night because the secretion of saliva is decreased while asleep (Llena-Puy, 2006; Dawes, 2008), which creates an oral environment that is more able to support and enhance the growth of microorganisms (Srivastava, 2011; DAAA, 2005, Smales and Yap, 2006). Using fluoridated toothpaste at night maintains the protective effects of fluoride overnight while asleep (Duckworth and Moore, 2001) because the oral biofilm is reduced in density when the saliva flow in the oral cavity decreases during sleep (Dige, Schlafer, and Nyvad, 2012). It is also important to brush the teeth first thing after waking up in the morning and before breakfast (Amaechi and Higham, 2005) because fluoridated toothpaste will not only protect the teeth against acid or caries attack but will also act as a mouth freshener (Amaechi and Higham, 2005; Attin and Hornecker, 2005). Overall, there is evidence to support the appropriate frequency of toothbrushing and to suggest there is an ideal time to brush teeth.

2.3.1.4. Post-brushing rinsing

The PHE guidelines (2014a) also encourage spitting rather than rinsing after brushing the teeth and discourage use of any form of mouth rinse, including water and mouthwash (PHE, UK, 2014a). The main reason for this recommendation is to maintain a high concentration of fluoride in the oral cavity. Support for this PHE guideline recommendation is the citing of a reference to a clinical study by Chestnutt and colleagues (1998). However, in addition to being almost two decades old, this study was conducted exclusively on adolescents with an average age of 12.5 years. Indeed, this recommendation may actually be misconceived as evidenced in a more recent review by experts who suggest that the best practice is to use fluoride rinses post-brushing to increase fluoride retention in the mouth (Pitts et al., 2012). These fluoridated mouth rinses are recommended to contain 0.05% sodium fluoride and are

encouraged for daily application to sustain the beneficial effect of fluoride (PHE, UK, 2014a). In summary, post-brushing rinsing with fluoride is encouraged, and rinsing with water is discouraged.

2.3.1.5. Other fluoride modalities

Other home-based modes of fluoride delivery, including gels, mouth rinses, and water fluoridation, have all been shown to be effective in reducing dental caries (Marinho, 2009). However, the effectiveness varies between the modes; for example,the average prevention of dental caries in permanent dentitions from fluoridated mouth rinses is 26%, whereas that from gels is 28% (Daly et al, 2013). Water fluoridation was show to play a role in decreasing dental caries among children, but the effectiveness was limited (Sheiham and James, 2015). The application of water fluoridation has no effect on caries among adults. For example, caries progressed in Australian adults although water fluoridation was used (Slade et al., 2013). Also, a systematic review shows that caries decreases in areas where there is no water fluoridation (Marinho, 2009). Systematic and critical reviews provide evidence of the effectiveness of fluoride in reducing dental caries, but the effectiveness is limited and does not eradicate the caries (Moynihan and Kelly, 2014; Sheiham and James, 2015). However, the use of flouirde interventions with internetions aimed to reduce free sugars intake could ehelp in eradicating dental caries.

Overall, it appears that there is evidence to support a positive association between fluoride application (using of fluoride toothpaste, brushing gently twice per day, and using fluoride rinse post brushing) and reduction of dental caries. Furthermore, there is evidence that other home-based fluoride topical applications (mouth rinses and water fluoridation) can reduce dental caries. However, the effectiveness of fluoride application in reducing dental caries is limited in children and more so in adults. Hence, more interventions are needed to tackle the main cause of dental caries, which is the intake of free sugars (Sheiham and James, 2015).

2.3.1.6. Interdental cleaning

In addition to toothbrushing, one of the most common recommendations given by oral health professionals is to regularly use interdental cleaning tools to reach interdental

areas that cannot be reached by toothbrushes. Interdental cleaning once a day, before brushing the teeth, is recommended in order to maximize the amount of fluoride reaching interproximal areas (American Dental Association, 2014). This section reviews the most commonly examined interdental devices.

The PHE guidelines (2014a) recommend using dental floss or dental tape for small spaces between teeth, interdental brushes for large spaces, and specialised kits for orthodontic appliances. A more recent review by Sambunjak et al. (2011) concluded that there is no scientific evidence to support or refute the effectiveness of dental flossing in preventing tooth decay in adults. This result was supported by a systematic review by Hujoel and colleagues (2006), who confirmed that there is a lack of clinical trials regarding flossing for adults. Additionally, studies are often fraught with methodological problems, such as comparing the mechanical action of flossing with the chemical processes of mouthwash for plaque control (e.g., Mythri, et al., 2011), which further calls into question the findings of research on dental floss

The other type of interdental device is called an interdental brush. A systematic review by Poklepovic et al. (2013) did not find any strong evidence that supports or refutes the effectiveness of interdental brushes in reducing dental caries among adults. The conclusion that can be drawn from the available evidence is that because of a lack of direct research on interdental caries and interdental brushes, more high quality evidence is required before recommendations can be made.

Another, more traditional, method of interdental plaque control is the use of wood sticks. The advantages of wood sticks include they are simple to use (Galgut, 1991) and can facilitate the reshaping of interdental soft tissues in patients with periodontitis (Bear and Morris, 1977). The latest and most advanced interdental device is the oral irrigator, which is a device that applies fluid under pressure to remove debris and dental plaque (Parker, 2015). There are no reports that assess the effectiveness of oral irrigators and wood sticks in reducing dental caries among adults.

In conclusion, there is no strong evidence to support or refute that interdental cleaning devices prevent dental caries among adults.

2.3.1.7. Routine dental attendance

A routine dental check-up is an opportunity for regular clinical dental charting, advice, investigation, monitoring, and reporting of the patient's oral condition (NHS Executive, 2002). Since 2004, the National Institute for Clinical Excellence (NICE) has changed the dental check-up interval from six months for all patients to between three and twenty-four months for adults (NICE, 2004). There are two main reasons for this change. This update was based on a systematic review on the clinical and cost effectiveness of regular dental attendance in both adults and children (Davenport et al., 2003a, 2003b) that revealed contradictory studies within the literature and suggested that there is no valid and reliable evidence that children and adults need a dental check-up every six months. These findings were supported by other systematic reviews (Beirne et al., 2005; Beirne et al., 2007; Patel, Bay, and Glick, 2010; Riley et al., 2013; Worthington et al., 2013). None of these reviews support or reject the application of the six-month dental interval in adults because of the limited nature and low quality of available studies. Additionally, there has been an increased use of fluoridated toothpaste in the UK, leading to less need for visits (British Dental Journal, 2004), and increased acknowledgment in the dental community that patients have unique needs and should be treated accordingly (NICE, 2004).

In conclusion, the available evidence indicates that a "one-recall-interval-fits-all" technique should not be adopted. Instead, the allocation of recall intervals should be tailored to the patients' oral health needs and a dental risk assessment.

2.3.1.8. Control of free sugars intake

The PHE of England (PHE, 2014a) encourages consumption of sufficient nutrients and a balanced diet, which will prevent oral diseases and sustain healthy gingivae and teeth. This can be achieved through eating fresh fruits and vegetables and reducing the amount and frequency of cariogenic foods to only mealtimes and no more than four times per day (PHE, 2014a). Also, they discourage the consumption of sugary foods at bedtime. In addition, adults are advised to consume <10% of the total energy or 60 g of added sugars per individual per day (PHE, 2014a). The WHO (WHO, 2015) strongly recommends that both children and adults not exceed the intake of free

sugars by >10% of the total energy per day and 5% of the total energy for conditional recommendation. *"Conditional recommendations are made when there is less certainty about the balance between the benefits and harms or disadvantages of implementing a recommendation"* (WHO, 2015; p.4).

The new recommendation of WHO (2015) is based on a systematic review that was conducted to verify the effect on dental caries of limiting free sugars intake to <10% and <5% of the total energy on dental caries and to determine the association between dental caries and the quantity of free sugars intake (Moynihan and Kelly, 2014). They concluded that a daily free sugars intake of <10% of total energy would have widespread health benefits, but that a further reduction of free sugars intake to <5% would yield the maximum benefit in terms of reduction of dental caries (Moynihan and Kelly, 2014; PHE, 2015). In addition, based on ecological studies, the target of <5% of free sugars intake from the total energy will prevent the progression of dental caries in the long term (Moynihan and Kelly, 2014). In other words, the DMFT will not increase with age. The SACN made a comprehensive review on the restriction of free sugars intake (SACN, 2015) and recommended the term 'free sugars' should replace 'non-milk extrinsic sugars' and describe all types of sugars that required minimal consumption. Also, they recommended that the population of the UK aged two years and above should consume free sugars at ≤5% of total dietary energy intake. Finally, they emphasised minimal consumption of SSDs for all ages.

The 5% of free sugars intake from the total energy is equivalent to 7-8 teaspoons (35g) of sugars for men and 5-6 teaspoons (25g) for women (Limb, 2014). However, there is no safe level of free sugars intake for teeth (Sheiham and James, 2014). For instance, in the study of Okuya (1960, cited in Sheiham and James, 2014), dental caries in molar teeth decreased when free sugars intake decreased from 8.5% to 5.5%, but the caries was not entirely eradicated. This means that reduction of free sugars intake will help in reducing the progress of dental caries in adults. Therefore, there is a need to develop and design an intervention based on a valid psychological model to reduce free sugars intake among adults to <5% and eventually reduce the progression of dental caries.

In summary, Literature related to home-based preventive approaches provides

evidence that oral health practices can help in reducing dental caries. Such practices include the regular brushing of teeth and control of the intake of free sugars. Although there is evidence to support the effectiveness of fluoride action in reducing dental caries, it is limited to children and adolescents and is a short-term effect. In some cases, fluoride application has no effect on dental caries. There is no evidence to support or refute the effectiveness of interdental cleaning and regular dental attendance in reducing dental caries among adults. However, these services are encouraged to be used according individuals' needs. There is stronger evidence to support that the reduction of free sugars intake will help to reduce dental caries among adults. Therefore, this PhD project focuses on the control of sugars intake among adults.

2.3.2. General health action

The previous subsection discussed oral health action to minimize the impact of free sugars intake on teeth. This section discusses general health actions that are suggested by the PHE following WHO (2015) and SACN (2015) reports and their analysis of the available evidence. In the previous section of factors that contribute to the consumption of high amounts of free sugars, many factors were discussed. The PHE (2015) summarises the factors in three main groups, namely influencers, the food supply, and knowledge, education, training, and tools. The influencers group includes factors that are used to influence individuals to purchase and consume free sugars; for examples, marketing and advertisement campaigns and promotions of sugary food product. The food supply group involves the availability of sugary food to be purchased by or offered to the individuals in market (e.g., retail stores, supermarkets, and restaurants); and non-market places (e.g., place of work and schools including universities). The knowledge, education, training and tools group is concerned with awareness and skills related to high consumption of free sugars by individuals. The PHE (PHE, 2015) declared eight actions that should act in parallel to help to overcome the three main groups of factors that contribute to high consumption of free sugars. Most of these actions target environmental context and resources. The eight actions are based on the analysis of evidence by the PHE and are discussed below.

2.3.2.1. Price promotions (Actions 1 and 5)

Most retailers in the UK promote unhealthy and high free sugars content food with special prices or offers. One of the free offers when buying sugary food is “buy one and get one for free” (Economic and Social Research Council, 2014). An example of price promotion is encouraging the purchase of sugary confectionary in a larger size that is cheaper than a single smaller size (Wansink, 2004; McDonalds, 2015). These promotions make individuals purchase the large volume in a sense as an incentive (saving money) for them (Wansink, 2004; McDonalds, 2015). More than 50% of offered foods and drinks in the retailers have high free sugars content (Economic and Social Research Council, 2014). This encourages people with different socioeconomic backgrounds to consume high free sugars content food (PHE, 2015). The motivation is through these kinds of promotional food cues that lead individuals to purchase higher sugary food (Wansink, 2004; Wansink and Sobal, 2007).

Therefore, the PHE (PHE, 2015) suggested (number 1) to all retailers to decrease all types and number of promotional prices among all sugary food and rebalance price promotions with healthier food (e.g., fruits and vegetables) to help individuals choose to purchase healthy food easily. This suggestion is supported by some evidence from two recent systematic reviews (Gittelsohn, Trude, and Kim, 2017; Afshin et al., 2017) that both reported promoting healthy foods increased their consumption. However, some of the reported studies indicate that retailers find it easy to encourage the purchase of healthy food without discouraging the buying of unhealthy food, which can act as a barrier to an optimal decrease in purchase and intake of high free sugars items (Gittelsohn, Trude, and Kim, 2017). Also, food pricing would be more effective in combination with multicomponent interventions (Afshin et al, 2017); for example, in combination with the eight suggestions of the PHE (PHE, 2015).
Also, the PHE suggested (number 5) a minimum of a 10 to 20% increase in the price for all high sugary foods and drinks that could be in the form of a free sugars tax on all sugary drinks. A systematic review of this practice indicates that more taxation of high free sugars foods and SSDs helps to reduce consumption of these sugary foods in the short term (Roberts et al., 2017). However, there is limited evidence that free sugars taxation can help decrease obesity because of multiple complexities in the behaviour of the consumers and the effects of substantiation (Maniadakis et al., 2013). In contrast, there is some evidence that 20% taxation on SSDs can help to reduce progression in dental caries, especially in young, low-income males, leading to

reduced inequalities in the spread of dental caries experience among the population (Schwendicke et al., 2016). In light of this evidence, more research is needed to support the findings from the model-based approach of Schwendicke et al.. (2016). There is evidence from a systematic review that taxation on SSDs delivers similar effect on consumption among both low and high income groups (Backholer et al., 2016). Unfortunately, free sugars taxation alone is not sufficient to reduce health concerns due to free sugars consumption. A multiple structured strategy is needed to help in tackling the issues (Rastrollo et al, 2016).

2.3.2.2. Marketing and advertisement (Action 2)

Food industries spend £250 million in promoting unhealthy foods and drinks, including those with high free sugars content (Neilsen Media Research, 2014) through in-store displays (PHE, 2015). Advertisement and marketing is prevalent in many forms, such as TV advertising, radio, advergames, and online advertisement. Drinkand food companies' sponsorships in TV programmes affect individuals' food preference, buying, and choice across different ages (PHE, 2015). One study found that TV or screen advertisements effectively increase the intake of high free sugars content foods and drinks among adults (PHE, 2015). However, two systematic reviews (Mills, Tanner, and Adams, 2013; Boyland et al., 2016) found that food industries advertisements influence children rather than adults (Boyland et al., 2016) and that more high quality research is needed to assess the effects of food and drink advertisements on adults' food consumption (Mills, Tanner, and Adams, 2013). However, the PHE (PHE, 2015) suggested to dramatically reduce marketing and advertisement of high free sugars food and drink products to individuals across all ages, including all media digital platforms and sponsorship events by foods and drink companies. It is of interest that two studies (experiment and cohort studies) claim that healthy food advertisements lead to selection of healthy foods or snacks among adults (Dovey et al., 2017; Morley et al., 2018).

2.3.2.3. Definition for high sugary foods and drinks (Action 3)

The third action is to set terms and condition for high free sugars food that can help in facilitating action one five and two (PHE,2015).

2.3.2.4. Portion Size (Action 4*)*

Larger portion sizes and packaging of unhealthy food including sugar- sweetened beverages (SSBs) are associated with the increase of consumption of these foods leading to unhealthy consequences including dental caries, this based on the systematic (Hollands et al., 2015). Therefore, the fourth action suggested by Public Health England is to introduce programmes that aim to help individuals to gradually reduce consumption of free sugars everyday with every foods and drinks; this should be accompanied by portion size reduction (PHE, 2015). This is because smaller packaging and portions would contribute to reduce free sugars intake (Hollands et al., 2015).

2.3.2.5. Provision and sale (Action 6)

There is some evidence that reduction in free sugars intake is associated with limited availability of high sugary foods and drinks in shops, takeaway and public places including schools, hospitals and universities (Stephens et al, 2014; Winpenny et al, 2017). Also, there is some evidence that providing lower free sugars content foods and drinks in shops restaurants and public places could lead to successful reduce the intake of free sugars; this approach was successfully noticeable in salt reduction case (PHE, 2015). Therefore, the sixth action is to provide and sale low free sugars content foods and drinks and healthy food across the public sectors at all levels including national and local sectors involving hospitals and universities, through adaptation, implementation and monitor the buying standards of the government for cooking service and foods (PHE, 2015).

2.3.2.6. Accredited Training in diet and health (Action 7)

In the society and professional background, there are individuals who can influence other to reduce free sugars intake (PHE, 2015). There is evidence which suggests that training workers (e.g. childminder, caterers, and fitness instructors) about lower free sugars intake can have positively impact the consumption of free sugars intake (PHE, 2015). For instance, in Singapore, street marketers and other caterers received training from dieticians on healthy diets; which helped individuals to understand the potentials of quality diet (WHO, 2018). Similar principle can be applied but in dental settings, where dental professionals are trained about healthy eating and diet including lower consumption of free sugars (Moynihan et al, 2018). Therefore, the seventh action is

the delivery of accredited training in diet and health including free sugars intake to all individuals who can influence on food choices; this would include areas in catering, sport and fitness centres and others within local authorities (PHE, 2015).

2.3.2.7. Knowledge and skills (Action 8)

Relevant knowledge and skills about reducing free sugars intake are important and can contribute to improve individuals' knowledge and skills which could lead to healthy eating (Hattersley et al, 2009; PHE, 2015). This could take in different form of short courses and campaigns about healthy eating; examples of these action are Change4Life, 5 A day and Eatwell (PHE, 2015). Therefore, the eighth action that could help to reduce free sugars intake to the recommended level is to raise awareness about free sugars intake and provide necessary skills to individuals across different sectors include public and private (e.g. Food industries) to reduce their free sugars consumption (PHE, 2015).

In summary, in this section, eight general health actions were discussed based on Public Health of England recommendation (PHE, 2015). These interventions focus on four intervention functions related to Behaviour Change Wheel System, which are Training, Education, Restriction, and Environmental Restructuring (Michie, Atkins, and West, 2014). However, the success of the eight actions (interventions) is not to apply them separately instead applying them together parallel, could help in successful reducing the free sugars intake as indicated by other studies (Rastrollo et al, 2016). Other actions applied currently by the government which are not stated in the Public Health of England strategy, such as food labelling on food products and the main reason is their utility by the public is limited to individuals who aim to lose weight or have health issues such as diabetic (Ipsos Mori, 2010). Other proposals, such us health warnings, which are similar to cigar package, food menu labels were not considered in the actions (Mwatsama, 2014). It is not obvious if these actions by Public health of England were developed based on a psychological model.

2.4. Methods of behavioural changes

In the previous sections we have discussed the oral and general health actions to prevent dental caries and consumption of high free sugars. The control of free sugars intake heavily relies on individuals' behaviour to change, however there are number

of factors contribute to the control of free sugars intake as mentioned in previous sections. There are different methods to achieve the desired behaviour e.g. less free sugars intake. However, many of these methods take into account the contributing factors to high free sugars intake. There are a wide range of methods, which has been used to change behaviour, this including: oral health education, psychological models or theories and behaviour change frameworks the methods. This section of the literature discusses the application of the methods and their limitations in details.

2.4.1. Oral health education

Oral health education is an educational activity which aims to achieve oral health related goals though increasing knowledge which leads to change in attitude and ultimately change the behaviour (Daly et al., 2013). It is based on the three domains of learning: cognitive, affective and behavioural (Daly et al., 2013). Oral health education has been a crucial and integral element of dental services for a century at different community levels (Kay and Locker, 1996). There are different means of applying oral health education including mass-media campaign and school health education. Three systematic reviews had similar findings in relation to the effectiveness of traditional oral health education approach (Kay and Locker, 1996; Habbu and Krishnappa, 2015; Kay et al, 2016). Kay and Locker, (1996) found that oral health education had no evidence in reducing dental caries incidence and ambiguous evidence of oral health education to improve diet control. Similar findings were reported by Habbu and Krishnappa, (2015), limited evidence to support oral health education to reduce dental caries incidence.

Kay et al. (2016) Found that there is strong evidence of interventions based on behaviour change models such as motivational interviewing improve gingival conditions and oral hygiene. In addition, they found that there is strong evidence of educational written material such as leaflets helped to improve the knowledge of the patients, but no evidence of their influence on patients' behaviour. Finally, weak evidence to support the theory which indicates that improving knowledge leads to improve behaviours will improves, if any changes in behaviours, it will be in short terms (Kay and Locker, 1997; Kay et al, 2016; Gupta et al, 2018). Werner et al, (2016) conducted a systematic review assessing the effectiveness of psychological intervention on improving oral hygiene compare with traditional oral health education

among adults and adolescents. They reported no statistical significant difference between interventions based on psychological models and traditional oral health education in relation with plaque presence and inflammation of gingivae. However, there was small statistically significant difference for interventions based on psychological models to decease plaque index compare with the traditional method (Werner et al, 2016). Werner et al, (2016) identified six RCTs that compared psychological interventions with traditional oral health education; and the follow up of the intervention were short terms. Therefore, it is not a surprising claim of them, because all the included RCTs had short term follow up; this does not contradict with previous systematic reviews (Kay and Locker, 1997; Kay et al, 2016; Gupta et al, 2018). The findings from the systematic reviews confirm that providing education or information about caries or diet alone is no sufficient to change the behaviour. This is because the traditional oral health education programmes do not consider other factors, which influence the behaviour of individual including environmental and social factors (Habbu and Krishnappa, 2015)

2.4.2. Theory based approach

2.4.2.1. Related definitions

Before the discussion of behaviour change theories, it is important to define some relevant terms. Theories provide important frameworks to increase our understanding of the determinants of a wide range of health behaviours (Newton and Asimakopoulou, 2015). A theory is defined as "a set of interrelated concepts (constructs), definitions and propositions that present a *systematic* view of events or situations by specifying relations among variables, in order to *explain* or *predict* the events or situations" (David et al, 2014; **Glanz & Rimer, 2005, p. 4**; National Cancer Institute, 2005; Babbie, 2003; Glanz and Rimer, 1995). Also, it can explain the relation between one phenomenon to another (Bem & Looren de Jong, 1997). Therefore, Craig et al (2008) suggested that a theory can be used to understand behaviour and used to design and develop intervention to improve the behaviour. The constructs are main concepts within a theory (National Cancer Institute, 2005; Glanz and Rimer, 1995) and predictors are constructs that are used to predict actions, but they are not directly associated with a theory (Michie and Prestwich, 2010). The other important term is explanation which means the identification of factors underlying behaviour and intentions and how there are related or combined together to

understand behaviour (Sutton, 1998). Models that can understand the behaviour can make interventions more effect in changing behaviour. However, theories or models that cannot predict behaviour, are more likely unable to explain the behaviour, (Sutton, 2004), which means that interventions based on such theories will not be effectiveness in changing behaviour. Saying that, predictive theories can guide in intervention development, but the interventions might not be effective in changing behaviour (Sutton, 2004). In short, effective interventions in changing behaviour are based on theories that can explain and predict behaviours.

2.4.2.2. Behaviour change theories

Therefore, theories of behaviour change have been found essential in the predicting behaviour change (Davis et al., 2014; Munro, 2007; Ogden, 2004; Forshaw, 2002); interventions based on such models have been shown to be better prediction of behaviour changes than non-theory based interventions (Abraham et al., 2009; Srigley et al, 2015). There are 82 behavioural change theories, which were used in psychology, anthropology, sociology, and economics (Davis et al, 2014). Of these, four are the most commonly used in the literature: Transtheoretical Model of Change (TTM), Theory of Planned Behaviour (TPB), Social Cognitive Theory (SCT) and Information-Motivation-Behavioural-Skills (IMB) Model. These theories and models are part of Social Cognition Models (SCMs) that assume that the individual's attitude and beliefs towards a behaviour are strongly predictive of the likelihood of them engaging in that behaviour (Newton and Asimakopoulou, 2015). Therefore, there is a suggstion that intervetions-based SCMs could be improving an individual's behaviour (Albarracin et al., 2005; Hobbs et al., 2013). In a discussion of the weaknesses of the extant literature, Michie and West (2013) instead argue that the two models that most comprehensively capture the full range of factors that influence behaviour are PRIME Theory of motivation and COM-B Model, which is part of Behaviour Change Wheel framework. The Behaviour Change Wheel is framework that offers understanding of behaviours and set plan to improve the behaviour thought systematic process (Michie, van Stralen, and West, 2011), which is explained late in this section. This section summarizes the key features of the four most commonly applied explanatory frameworks – the Transtheoretical Model of Change, Social Cognitive Theory, Theory of Planned Behaviour, Information-Motivation-Behavioural-Skills Model—along with examining PRIME Theory. COM-B model will be discussed in section 4.5

and because the model is part of Behaviour Change Wheel. For each theory and model, the key features of the theory will be explained, followed by a review of their usefulness for supporting general behaviour change, and their application to oral health settings in terms of their predicting of behaviours and changing the behaviour via interventions.

2.4.2.3. Transtheoretical model

Key features

The Transtheoretical Model (TTM), also known as the Stages of Change model, is stage-based and that assumes that behavioural change needs to progress in a sequential manner (Rutter and Quine, 2002). While the stages build on one another, the authors claim that progression between stages does not need to be in a linear manner (Morrison, and Bennett, 2006; Ogden, 2012; Michie et al, 2014), but instead occurs through a spiral motion (Prochaska, DiClemente, and Norcross, 1992). This spiral model appears to be an attempt to indicate that while progression towards positive behaviour change needs to happen one stage at a time, without the option of skipping stages, a relapse is possible at any time that can lead to the individual regressing to any previous stage.

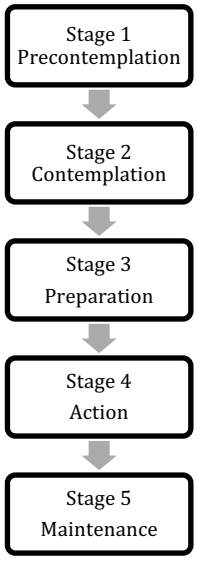

Fig.5. The five main stages of TTM adopted from Rutter and Quine, (2002).

TTM consists of five stages moving from precontemplation, to contemplation, preparation, action, to maintenance, as depicted in figure five (Ogden, 2012; Michie

et al, 2014). Precontemplation is where the individual is neither thinking nor planning to change. In Contemplation the individual intends to change within the next six months. Preparation involves an individual taking active initial steps to initiate change within the next six months. Action takes place where the individual is engaging in some sort of behaviour change. Finally, maintenance is the stage where the individual is repeatedly engaging in the behaviour over a period of more than 6 months. While a sixth stage which involved individuals having no probability of relapse, called termination, was at one point proposed by the original authors of the model, it has since been abandoned because it was considered to be unlikely in reality (Prochaska and Velicer, 1997).

To move from one stage to another, an individual must apply specific *processes* (Morrison and Bennett, 2006). Processes in this context have been defined as "open and hidden cognitive behavioural activities that are performed by the people for progressing through behavioural stages" (Tavakoli and Falahi, 2013, p.6). The model proposes ten different processes of change (Michie et al, 2014). For example, 'consciousness raising', which may involve an individual accessing more accurate information and realizing that a problem behaviour exists, is proposed to be the necessary process to move from precontemplation to contemplation. Table two defines the ten processes and their application intermediary the stages.

Table Two: Defining the ten processes of TTM with examples adopted from Michie et al, (2014)*:

Processes *	Definition*	Intermediary between*	Examples
Consciousness raising.	Raise awareness of the risk of wrong behaviour and share accurate information about it	Precontemplation stage and the contemplation stage.	Counselling
Dramatic relief.	Be aware of Feelings towards wrong behaviour and its solutions	Precontemplation stage and contemplation stage.	Role play

Environmental re-evaluation	Thinking and emotional evaluations of the impact of stopping wrong behaviour in the society and environment	Precontemplation stage and contemplation stage.	Family interventions
Self-re-evaluation.	Thinking and emotional evaluations of the impact of stopping wrong behaviour on the individual himself (develop a new self-image)	Contemplation stage and the preparation stage	Values characteristics
Self-liberation.	Self-belief on the ability to change	Preparation stage and action stage.	Planning, commitment
Helping relationships.	Supporting for change	Action stage and maintenance stage.	Empathy, honesty, and trust are characteristics of supportive relationship
Counter conditioning	Replace wrong behaviour with good behaviour (substitute)	Action stage and maintenance stage.	Ensure that there are no other options for bed oral hygiene
Stimulus control.	Cues for desired behaviour should be improved and cures for undesired behaviour should be decreased	Action stage and maintenance stage.	Externally: increase facilities for good oral hygiene Internal: self motivation
Reinforcement management	Rewards for desired behaviour and punish for undesired behaviour	Action stage and maintenance stage.	Rewards
Social liberation.	Getting support from the society and environment		Changes in social, policy or environmental factor

In addition to the processes, Michie et al (2014) posited the importance of additional ***intervening variables*** namely: decisional balance, self-efficacy, and temptation.

Decisional balance is the process of assessing the positive and negative aspects of a new desired behaviour, self-efficacy is an individual's belief regarding his or her ability to perform a desired behaviour, and temptation is defined as variables which encourage engaging in the unwanted behaviour (Michie et al, 2014). Different levels of each of these three variables are thought to underlie each stage of the model.

Application to general health settings

TTM has been applied to changing a number of health-related behaviours, including eating-related behaviours and smoking cessation. A systematic review of 27 studies by Di Noia and Prochaska (2010), who concluded that TTM was useful for understanding the decision-making processes regarding change for eating-related behaviours. Similarly, Hoetzel et al (2013) concluded from a systematic review of 15 studies that TTM is useful for assessing motivation to change for individuals with eating disorders. Also, in favour of the model, from a systematic review of 87 studies, Spahn et al (2010) suggested that the TTM has been repeatedly validated, and provides useful strategies for dietary behaviour change and meaningful outcome measures. There is also evidence to support the use of TTM for smoking cessation. In a systematic review of 41 RCTs, Cahill et al (2010) found supporting evidence for the use of TTM for smoking cessation, and in a further systematic review of 28 studies, Stanton and Grimshaw (2013) found that there was moderate evidence to support the use of TTM for smoking cessation in young people. Finally, Bully et al (2015) reported that there is strong evidence that the TTM improves smoking cessation in the long term.

While there is ample support for TTM for eating-related behaviour change and smoking cessation, there is little or no evidence that it is effective for other health-related behaviours such as physical activity. A review of three RCTs by Mastellos and colleagues (2014) found no support for the efficacy to produce sustainable changes in weight loss. It appears that TTM may be effective only for certain health related behaviour changes, such as changing eating-related behaviours and smoking cessation, but ineffective for others, such changes in physical activity. This may indicate that the TTM is applicable for certain health related behaviours.

Application to oral health settings

The TTM has been applied to a number of oral health behaviours and oral hygiene adherence. A systematic review of the effectiveness of interventions based on behaviour models for promoting individuals' oral health reported that the TTM is effective in changing behaviour when it is combined with Motivational Interviewing (Yevlahova and Satur, 2009). However, the authors drew this conclusion on the basis of one observational study, which provided little information on the nature of the intervention. Furthermore, the separate effects of the TTM and Motivational Interviewing could not be separated in this study.

Two systematic reviews of psychologically-based interventions for increasing adherence to oral hygiene instructions in adults with periodontal diseases (Newton and Asimakopoulou, 2015; Renz et al. 2007) revealed that TTM studies were generally of low quality, so no firm conclusions could be made about the effectiveness of TTM for improving periodontal adult patient adherence to oral hygiene instructions (Renz et al. 2007). However, some support was found for self-efficacy alone in predicting oral health behaviours (Newton and Asimakopoulou, 2015). In addition, the processes posited by the model which has shown to be effective in promoting change, independent of the stages in the model (Renz & Newton, 2009).

In relation to tooth brushing, there is one RCT pilot study that assessed the usefulness of educational intervention based on TTM (Wu and Switzer-Nadasdi, 2014). Based on self-report, 25.4% of participants reported improvements in their oral hygiene behaviours including tooth brushing. While this shows some promise, it also means that three quarters of the participants were not influenced by the intervention. The study had limitations including the use of convenience sampling (Wu and Switzer-Nadasdi, 2014). Further, the number of participants in the follow-up sessions was low, indicating high rates of attrition.

For Interdental cleaning, there is some research in support of the use of TTM. Hashemian et al (2012) conducted a clinical trial to identify the impact of education programme based on TTM and the use of interdental cleaning among senior schoolchildren. The authors concluded that the findings demonstrated that the model had a significant positive impact on improving the outcome of the educational

programme, and increased the number of students at the maintenance stage compared with the control group. The authors also claimed that it decreased the perceived barriers and increase perceived benefits due to an increase in self-efficacy (Hashemian et al, 2012). However, the intervention was not based on any of the components of the TTM, rather the authors only measured two outcome measures based on elements of the model, thus it may be that the intervention led to change in stage rather than the TTM effecting change. Tavakoli and Falahi (2013) showed that the intervention based on the model had positive impact on improving understanding of inter-dental cleaning behaviour. However, both studies had methodological weaknesses, including a lack of clear methods of randomization, which increases the chances of allocation bias. No studies were found that assess the application of TTM to reduce free sugars intake aim to prevent dental caries among adults.

For dental attendance, there has been no research on the potential usefulness of TTM for regular dental attendance among adults.

A recent systematic review of psychologically-based interventions effectiveness for reducing free sugars intake related dental caries among adults when compared with educational interventions or no intervention concluded that there is a need for more clinical trials to examine the effectiveness of interventions based on TTM in reducing dietary free sugars intake among adults (Al Rawahi, Asimakopoulou, Newton, 2017). In addition, two systematic reviews were conducted to find out the effectiveness of interventions based psychological models including TTM to improve periodontal conditon. There was no strong evdience to support the effectiveness of interventions based on TTM to improve periodontal conditions (Renz et al, 2007; Newton, and Asimakopoulou, 2015).

In summary, while there is some evidence that TTM can be effectively applied to changing eating-related health behaviours and smoking cessation, its application to other health-related behaviours is very limited. Notwithstanding the findings above, the TTM has been criticised extensively. For example, it has been postulated (Ogden, 2012) that the notion that individuals must progress through stages is unwarranted, as

it is possible for individuals to progress immediately from wanting to change (stage 2: contemplation) to never engaging in the behaviour again (stage 5: maintenance), without passing through intermediate stages. Secondly, the model has been critiqued for non-specificity; there is currently no evidence to assure researchers that the positive effects observed in some TTM studies are simply due to the fact that *an* intervention is being given, rather than being specifically due to TTM-based interventions. Thirdly, most studies of the TTM are cross-sectional studies, demonstrating a relationship between behaviour and stage, rather than the impact of an intervention (Ogden, 2012). Fourthly, there is no systematic rules in TTM to assign individuals to stages (Sutton, 2000). Finally, West (West, 2005; 2006), makes a compelling argument as to why TTM should be 'put to rest', detailing a catalogue of problems with its theoretical basis, implementation, outcomes and philosophy, all of which are points within which the results of this review should be interpreted. Given the available evidence, this theory is therefore not preferred as the foundation for the current research project.

2.4.2.4. Social Cognitive Theory

Key Features

Social Cognitive Theory (SCT) considers behaviour to be the result of social influence and human cognitive processes (Sharma and Romas, 2012). It was originally called Social Learning Theory, but in 1986 Bandura renamed the theory to Social Cognitive Theory because the theory focuses more in psychosocial factors such as motivation than learning factors (Ziegler et al, 2005). SCT is based on the principle of "Triadic Reciprocity", suggesting that there are three factors that influence each other (See Figure six); behaviours, environments and person (an individual's personal and cognitive factors) which should be considered when understanding behaviour (Michie et al, 2014). However, the contribution of the three dimensions to behaviour change is not equal; the strongest factor generally influences the weaker factors (Bandura, 1989). For example, an adult with low tooth-brushing self-efficacy (a personal factor) will be less likely to brush their teeth (behaviour), which can lead to oral diseases (mediating factor) and ending up with a visit to the dental clinic (environmental factor) for treatment. Another example, an individual with poor understanding of the food labels (a personal factor) will be less likely to select food

with lower free sugars (a behaviour factor) when shopping in a supermarket (environmental factor).

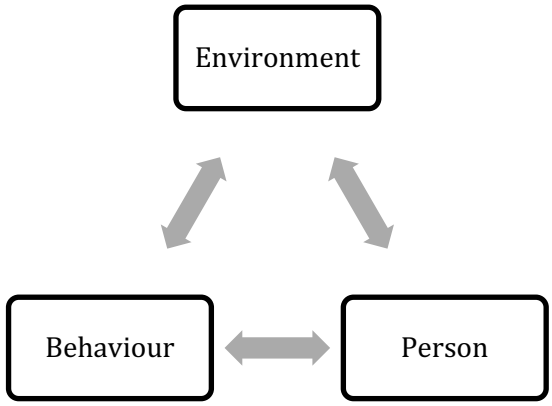

Fig.6. Triadic Reciprocity of SCT adopted from Crosby, Salazar, and DiClemente, (2013a).

However, the interaction between these three dimensions is not quite as simple as illustrated above, because within each dimension there are underpinning factors that explain or predict an individuals' behaviour, thought, and motivation (Sharma and Romas, 2012; Michie et al, 2014). These underpinning factors are called *capabilities* (Sharma and Romas, 2012; Michie et al, 2014). The theory posits that there are five of these capabilities. For example, the capability 'symbolizing' is the ability to apply symbols to transform an individual's experience into abstract mental models (Sharma and Romas, 2012; Michie et al, 2014). This is important because it allows an individual to plan courses of action by anticipating and evaluating possible behavioural outcomes. The other four factors of SCT are defined in the table 3.

Table Three: Five Factors underpinning the Social Cognitive Theory adopted from Sharma and Romas, 2012; Michie et al, 2014:

Capability	Definition
Symbolizing	Ability to apply symbols to transform individual's experience to "mental models".
Forethought	Ability to control behaviour based on future outcomes. E.g. goal setting and planning
Vicarious	Ability to gain behaviour or knowledge through observation. E.g. modelling others.

Self-regulatory	Ability to control or motivate one's behaviour via one's standard and evaluation of her/his behaviour. E.g. self-satisfaction
Self-reflective	Self-analysis ability of one's knowledge experience and thought

SCT also proposes *constructs*, which play an important role in explaining and predicting behaviour (Sharma and Romas, 2012). A construct is thought to predict behaviour, and some of the most important constructs for this particular theory are self-efficacy, goals, outcome expectations, outcome expectancies, socio-structural factors, and knowledge. These constructs are interrelated (Clark, and Houle, 2009; Albery and Munafo, 2008; Abraham et al, 2008; Luszczynska, and Schwarzer, 2005; Crosby, Salazar, and DiClemente, 2013a; Sharma and Romas, 2012; Sanderson, 2013). For example, according to Sanderson (2013), individuals high in self-efficacy tend to act on their knowledge. However, the list of the constructs is not the same among authors (Clark, and Houle, 2009; Albery and Munafo, 2008; Abraham et al, 2008; Luszczynska, and Schwarzer, 2005; Crosby, Salazar, and DiClemente, 2013a; Sharma and Romas, 2012; Sanderson, 2013). This indicates that the theory has many proposed constructs, although some of these have not been adequately tested which can create confusion. Table 4 presents the list of constructs with associated references, and table 5 defines those constructs that have been used in at least two publications.

Table four: List of constructs of Social Cognitive Theory:

List of constructs	Authors
Efficacy and Outcome expectations	Clark, and Houle (2009)
Self-efficacy and outcome expectancies	Albery and Munafo (2008)
Goals, Outcome expectancies, Self-efficacy, Socio-structural factors	Abraham et al (2008)
Goals, Outcome expectancies, Self-efficacy, Socio-structural factors	Luszczynska, and Schwarzer, (2005)
Knowledge, perceived self-efficacy, Socio-structural factors. Outcome expectations, goal formation	Crosby, Salazar, and DiClemente, (2013).
Knowledge, outcome expectancies, Outcome	Sharma and Romas, (2012).

expectations, situational perception, environment, self-efficacy, self-efficacy in overcoming impediments, goal setting, emotional coping.	
Self-efficacy and outcome expectancies	Sanderson, (2013)

Table five: Defines the commonly stated constructs of SCT :

Constructs	Definition
Self-efficacy /Perceived self-efficacy	Individual's beliefs/ perception about his or her ability in performing a particular behaviour (Clark and Houle, 2009; Crosby, Salazar, and DiClemente, 2013). Individuals go to three phases of self-efficacy: pre-action, maintenance, and recovery (Luszczynska, and Schwarzer 2005).
Goals/ Goal Settings/ Goal formation	Developing plans and forming goals to achieve targeted behaviour and goals are divided in two categories: distal and proximal (Sharma and Romas, 2012).
Outcome expectancies (value)	Individual's value placed on anticipated outcome of behaviour (Sharma and Romas, 2012). There are three types of values: physical, social and self-evaluative (Luszczynska, and Schwarzer 2005).
Outcome expectations (probability)	Anticipated likelihood of the outcomes from a behaviour (Sharma and Romas, 2012).
Socio-structural factors	Factors within social structure that facilitate or imped behaviour change (Bandura 1997). So there are two types impediments and facilitators (Luszczynska, and Schwarzer 2005).
Knowledge	Facts and information that are learnt. (Sharma and Romas, 2012).

Application to general health settings

SCT has been applied widely in the context of general health behaviours including adherence to medication, sexual behaviour, physical activities, weight loss, and drug

abuse behaviours (Luszczynska, and Schwarzer 2005; Sharma and Romas, 2012). In a systematic review with meta-analysis Young et al (2014) conducted found that SCT was able to predict 31% of the variance in physical activity behaviours (Young et al, 2014), leaving 69% unpredicted by the theory. The study also revealed that the 'goals' and 'self-efficacy' constructs were positively associated with physical activity, unlike other constructs such as socio-structural factors and outcome expectations, which were negatively related (Young et al, 2014). However, many of the included studies assess the predictable of the theory and their constructs, which does not adequately address causality relationships that are important to assess the intervention based on the theory or their constructs. This indicates the need for further RCTs to assess the effectiveness of interventions based on constructs of SCT (Young et al, 2014).

Another systematic review and meta-analysis was conducted by Stacey et al (2015) to assess the effectiveness of physical activity and diet behaviour change interventions based on the SCT among cancer survivors. The study identified that most of the included interventions were effective for enhancing diet behaviour and physical activities, but this effectiveness was not related to specific SCT constructs. However, when taken in isolation, self-efficacy was shown to be positively associated with behaviour change for diet and physical activities (Stacey et al, 2014).

In the last ten years, only two Randomised Controlled Trials have been conducted to examine the potential effectiveness of SCT for smoking cessation, Villanti et al (2010), concluded that the pooled results of these two RCTs support the use of SCT. However, both were conducted with college students, making the generalizability of these studies problematic, and one of the studies used a combined model of SCT and problem-behaviour theory. This lends some support to the possibility that SCT can be a useful theory for smoking cessation programs, at least for university students.

In summary, most of the systematic reviews identified that the constructs self-efficacy and goal setting are promising for promoting individual health behaviours, but other constructs remain largely unsupported. This means that SCT as a whole may not be the most effective theory for predicting health-related behaviours. However, it is also possible that this finding could be due to many interventions only applying a minimum number of constructs, rather than applying SCT as a whole (Abraham et al,

2008). Further research is needed to address this gap in the literature and to examine the appropriateness of SCT for health-related behaviour change.

Application to oral health settings

SCT has been applied in oral health related behaviours including adherence, and oral hygiene practice.

For tooth brushing, two simultaneous RCTs were conducted to test the effectiveness of oral health intervention based on two constructs; namely, self-efficacy and action planning (Clarkson et al, 2009). Patients in the intervention group developed better skills, timing, and duration of tooth-brushing and decreased plaque formation and gingival bleeding compared with patients who received routine care (Clarkson et al, 2009). The study also revealed that outcome expectations were related to high self-efficacy and planning among patients (Clarkson et al, 2009). This focus on construct rather than theory means that the full SCT is not actually assessed, leaving the role of SCT for tooth-brushing largely unexplored.

Staunton et al, (2014) in a trial of an education based intervention found a positive relationship between dental flossing, self-efficacy, and motivation. However, a number of limitations make these findings less reliable, including having a problematic outcome measure (residual floss), poor generalizability (only university students), and a very short-term follow up of one week, there was also no control group. Importantly the intervention did not target constructs within the SCT and other theory was used along with SCT.

Two systematic reviews have included evaluations of SCT for increasing adherence towards oral hygiene instructions in adult with periodontal diseases. In the first systematic review, Both Renz et al (2007) and Newton and Asimakopoulou (2015) identified that self-efficacy, goal setting, and planning were effecitve interventions for improving oral health behaviour in periodontal patients, though the evidence was derived from a small number of low quality trials. This suggests that at least some components of SCT may be effective for predicting oral health adherence. There is a need for more trials involving the application of SCT (Al Rawahi, Asimakopoulou, Newton, 2017).

There has been no research on the potential usefulness of SCT for regular dental attendance among adults.

In summary, some of the constructs related to SCT appear to be effective for changing behaviour – most notably self-efficacy, goal setting, planning, and outcome expectations. Particularly self-efficacy was the most often applied by the literature, and consistently found positive results. However, because often individual constructs were applied in isolation, rather than applying all SCT contstructs, it is difficult to judge whether SCT is an appropriate theory for health-related behaviour change. This piece-meal application may be due to an overly complex theory which may be difficult to apply all of the individual components (Sharma and Romas, 2012). Therfore, In its current form, due to the lack of empirical support, this theory is not considered the most appropriate for the current research project.

2.4.2.5. Theory of Planned Behaviour

Key Features

The Theory of Planned Behaviour (TPB) is a social cognition model that suggests that behaviours are the result of an evaluation of the positives and negatives of any given action (Ogden, 2012). The theory combines constructs to predict behaviours or intentions of individuals (Morrison and Bennett, 2006), including **a**ttitudes towards behaviours, subjective norms, and perceived behavioural control. Table 6 presents the definitions of the main constructs of TPB. Together, these contribute to the formation of behavioural intentions (Ogden, 2012). According to TPB, these intentions are crucial for causing behaviour. The only way these can be bypassed is through perceived behavioural control, which can lead to a behaviour without intention (Morrison and Bennett, 2006; Ogden, 2012); figure seven illustrates this relation.

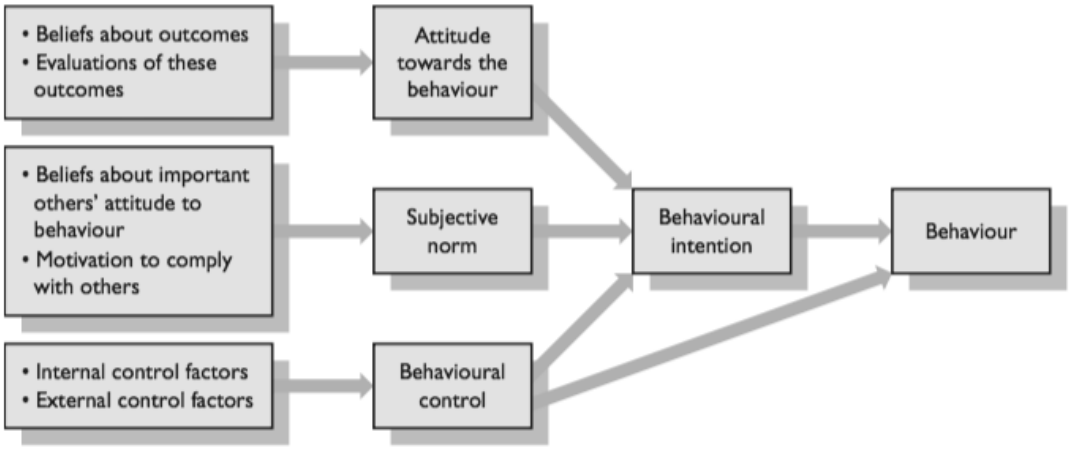

Fig.7. The Theory of Planned Behaviour adopted from Ogden, (2012)

Table six: Defines the main constructs of TPB (Ogden, 2012; Michie et al, 2014):

Constructs	Definition
Behavioural intention	The intend to act the behaviour
Attitude towards a behaviour,	Positive or negative representation of a behaviour Beliefs about the behaviour outcome
Subjective norm	Social norms perception and pressures to perform a behaviour, An evaluation of individual's motivation towards this pressure
Perceived behavioural control,	Individuals' belief in their ability in performing a particular behaviour considering two factors: Internal control factors (e.g. skills, abilities, information) External control factors which are opportunities)

Application to general health settings

The TPB has been applied to many aspects of general health and many recent systematic reviews have been conducted to assess the efficiency of the theory in predicting or changing behaviours. Thompson-Leduc et al (2014) conducted a systematic review to assess the efficiency of TPB for predicting Shared Decision Making (SDM) behaviours of different health care professionals. They found that subjective norms were the most predictive variable of SDM behaviours followed by perceived behavioural control and attitude (Thompson-Leduc et al, 2014). Also, they

found that intention was the most predictive construct of health professional's performance towards SDM actions. Similar findings were reported in another systematic conducted by Richard et al (2014), who concluded that subjective norms, attitude, and self-efficacy predicted the intentions of alcohol consumption.

There is strong evidence to support the use of TPB for smoking cessation programs; a meta-analysis study of 35 data sets from primary studies, and found that that the construct 'perceived behaviour control' the most predictive of smoking cessation because it influences both intention and behaviour (Topa and Moriano, 2010). The authors suggest that the culture of the country is also important as a mediating factor, with some cultures enhancing the effects of smoking cessation programs, mirroring findings from Buunk-Werkhoven and colleagues (2011). This suggests that particularly 'perceived behaviour control' may be relevant for understanding the effects of TPB for smoking cessation programs, and perhaps culture should be considered as an additional important factor.

In contrast Hackman & Knowlden (2014) in a systematic review did not find strong evidence to support the effectiveness of interventions based on TPB for dietary behaviour change in adolescents and young adults; this means that TPB might be effective in bringing the desired change. Oluka et al (2014) conducted a systematic review to assess the efficiency of questionnaires based on TPB and found that there were errors in the estimation of sample size; namely, demographic data, measures, and the process of development of the questionnaires. This means that there were methodological issues in the evaluation of many TPB interventions.

Based on these systematic reviews, it seems that constructs of TPB such as subjective norms and perceived behaviour control' are predicting behaviours of shared decision making and alcohol consumption and smoking cessation. However, there is no evidence to support that intervention based on TPB can be effective in improving behaviour such as dietary behaviour change.

Application to Oral health settings

The TPB has been extensively applied in oral health behaviours these including tooth brushing, dental flossing and dental attendance. The majority of studies have adopted

cross sectional designs to assess the predictive power of TPB variables on oral health related behaviours (LAvi and Groarke, 2005; Luzzi and Spencer, 2008; Defranc et al, 2008; Van Den Branden et al, 2013; Andreson, Noar, and Rogers, 2013; Dumitrescu et al, 2014). These studies support the ability of TPB variables in predicting intentions and behaviour of oral health.

Defranc and colleagues (2008), Van den Branden and colleagues (2013), and Dumitrescu and colleagues (2014) found that when broadly applied, the theory could successfully predict a significant portion of the variance in oral health-related behaviours. Defranc and colleagues (2008) found that they could successfully predict 57% of the variance in oral hygiene habits and 66% of the variance in dental attendance. Another study provided more cautious support of TPB (Buunk-Werkhoven, et al., 2011), suggesting that cultural differences may exist regarding the most appropriate application of the theory. The authors conducted a study to identify predictors of oral hygiene, and found that in the Caribbean the best predictors were attitude and social norms, while in Nepal, perceived behavioural control and expected social outcomes were most predictive.

Newton and Asimakopoulou (2015) reported only one RCT that had incorporated TPB constructs into the study. However, these were used as a basis of predicting behaviour change rather than the basis of the intervention. Their findings supported the findings of the clinical RCT by Sniehotta (2009) to assess the effective of TPB in changing behaviour. Sniehotta (2009) applied full-factorial experimental design to assess the effective of three interventions based on the main three TPB constructs to improve Physical activity. The choice of physical activity was based on the strong correlation of TPB to predict the behaviour (Sniehotta, 2009). Sniehotta (2009) found that the interventions changed the intention related to the behaviour, through TPB three construct. Saying that, the interventions failed to achieve behaviour change. This study suggests that TPB has limited influence on behaviour.

To date there is some evidence that TPB constructs can predict oral health related behaviour but little evidence to support their use as an intervention to change behaviour. Self-efficacy – termed perceived behavioural control in the TPB model – appears to be the most important component of the TPB for predicting behaviour.

In summary, there is some support for the use of TPB for changing some health-related behaviours, but there is need for more RCTs to assess the effectiveness of interventions based on TPB that aim to improve oral health-related behaviours (Al Rawahi, Asimakopoulou and, Newton, 2017). It appears that self-efficacy / perceived control is the most important component of the TPB for predicting behaviour from different systematic reviews such as the Newton and Asimakopoulou (2015). A major limitation of the theory is that it considers individuals as rationale decision makers (Ogden, 2012); however, this is not always the case. For example, patients with dental anxiety may not be attending dental clinic on regular basis (Milgrom et al, 2010); in this case the behaviour of not attending regularly is based on emotion (fear) rather than rational decision-making. Finally, the findings of this review need to be considered against recent work in the field suggesting that TPB is not that helpful a model in the design of behaviour change interventions, taking into consideration the work of Sniehotta (2009) who has explicitly outlined problems with the theory; Asimakopoulou and Newton (2015) have argued that the TPB is insufficient to use as a tool for behaviour change, but it can predict behaviour only which does not serve the purpose of behavioural change science. Because of these limitations, TPB is not utilized as the foundation of the current PhD research project.

2.4.2.6. Information Motivation Behavioural Skills (IMB) Model

Key Features

The Information Motivation Behavioural Skills (IMB) model suggests that individuals perform a behaviour only if they expect a net benefit from it (Crosby, Salazar, and DiClemente, 2013b). The three main constructs of the model are information, motivation, and behavioural skills; figure 7 illustrate the relationship between the constructs (Michie et al, 2014). The first construct is information, which focuses largely on the individual's knowledge and understanding of the benefits of the behaviour (Crosby, Salazar, and DiClemente, 2013b; Berlant and Pruitt, 2003). Knowledge that is not directly related to the desired behaviour change will not achieve a change (Michie et al, 2014). The second construct is motivation, which represents attitudes and subjective norms regarding a behaviour (Guest and Namey, 2015). The motivation should be specifically related to the desired behaviour change

(Crosby, Salazar, and DiClemente, 2013b). The third construct is behaviour skills, which represent actual skills related to the desired behaviour and individual's self-efficacy (Guest and Namey, 2015). For example, to increase the frequency of tooth brushing, individuals may need *relevant knowledge* about the optimal time to brush their teeth, positive attitude and *motivation* to brush more often, and the *skill* of time management.

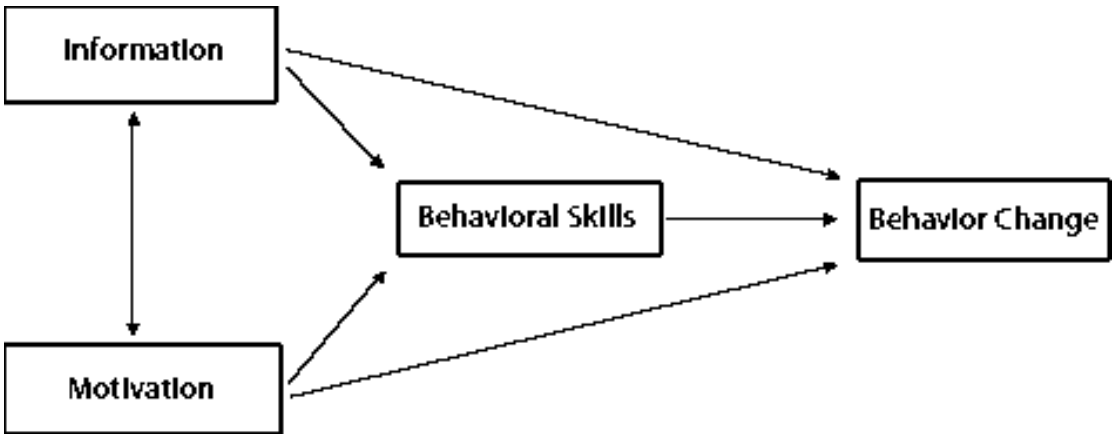

Fig.7. The Information Motivation Behavioural Skills Model adopted from Guest and Namey, (2015).

The relationship between the three constructs is illustrated in figure 7, which shows that both information and motivation can change an individuals' behaviour directly without building related skills or they can change behaviour through the mediator of behavioural skills (Crosby, Salazar, and DiClemente, 2013b).

There are three phases of implementing the IMB Model to change the behaviour of others; namely, elicitation, intervention, and evaluation (Fisher, Fisher and Shuper, 2009; Fisher and Fisher, 1992). Elicitation is the data-gathering phase where, for example, a healthcare provider may collect information about a patient's motivation, skills, and information. In the intervention phase, this is then used to design and implement an intervention that aims to change a behaviour. Finally, in the evaluation phase, the effectiveness of the intervention is then assessed. These three systematic stages of implementation are useful for practitioners and facilitate the application of the model to interventions, which other social cognitive theories such as TPB do not have in this manner.

Application to general health settings

The IMB Model has been applied to a wide variety of health-related behaviours. The IMB Model was originally applied to minimize HIV risk behaviours (Fisher, Fisher, 1992; Mimiaga et al, 2009; Fisher, Fisher and Shuper, 2009).). For instance, interventions based on IMB Model were used to promote women to use female condoms during intercourse with their partners (Mimiaga et al, 2009), and the model has shown to be effective in reducing the HIV risk behaviour between individuals (Fisher, Fisher and Shuper, 2009). As a result of this success, the application of the model has been applied to other health sectors including adherence to antiretroviral medicines (Fisher et al, 2006), breast-self-examination (Misovich et al, 2001), and motorcycle safety (Murray, 2000).

Directly examining the effectiveness of such interventions, within the last five years, three studies from different health domains have tested the effectiveness of IMB Model for changing behaviour (Ndebele, Kasese-Hara, Greyling, 2012; Kudo, 2013; Peltzer et al, 2013). The shared findings indicate that there is no strong evidence to support or reject the effectiveness of interventions based on IMB Model for sustaining new short-term health behaviour change. However, their findings are further called into question after a systematic review conducted by Sun Ju Chang et al (2014) and found that the IMB Model achieved healthy behaviour change that was sustained for 12 months. Because of this, it seems there is some evidence to support the use of IMB Model for health-related behaviour change for up to one year, but there is a need for more high quality studies to assess its effectiveness beyond a 1-year follow-up.

Application to oral health settings

The IMB Model has been applied in two studies related to oral health; to gather information and change the behaviour of oral healthcare providers and to examine the practicality of oral health education. In the first application, the IMB Model was used to assess prenatal medical staff and oral health workers' information, motivation and behavioural skills related to oral and systematic health during the prenatal stages (Vamos et al, 2014). Based on in-depth interviews of 22 workers, the study revealed that the IMB Model could be successfully applied to identify the needs of workers to elicit behavioural change.

The second study assessed the practicality of oral health education based on IMB model in improving oral health behaviour of HIV-positive adults (Vernon et al, 2014). The authors concluded that oral health instructions based on the IMB Model encouraged an increase in flossing (for 55% of participants) and tooth brushing (50%) and improved eating habits (32%). Despite these promising findings, caution should be expressed for a number of reasons. First, the studies were both based on very specific populations – prenatal care providers and HIV patients – and both were non-experimental. Additionally, in the Vernon et al (2014) study the IMB Model constructs were not directly assessed. There has been no effective research on the potential usefulness of IMB Model for tooth brushing, interdental cleaning, oral health adherence, and diet control related to dental caries in adults (Al Rawahi, Asimakopoulou, Newton, 2017).

Based on the literature, there are some promising applications of the IMB Model to changing general health behaviour for up to 1-year if researchers follow the three phases of model application when designing interventions. Because of this, there is some possibility that this model could also be useful for oral-health related behaviour change in short term. However, due to a lack of research related to oral health applications, this application remains uncertain.
Further there are some major limitations to the model. First, the model assumes that individuals are rational decision-makers (Simon-Morton, McLeroy and Wendel, 2012), but this is not always the case as individuals can engage in actions based on emotions (Morrison and Bennett, 2006). A criticism of the IMB model is its lack of specificity regarding the components of the three core constructs. Whereas other models specify the nature of the Information and Motivation elements, the IMB model is not as specific. Thus, any effectiveness may be because the constructs identified in the IMB process are similar to those in other models. In its current state, the IMB Model is not the preferred theory for this research PhD project.

2.4.2.7.PRIME Theory of Motivation

Key features

Although not a behaviour change theory in itself, given the central role that motivation plays in undertaking behaviour change, the PRIME theory of motivation is reviewed here. The PRIME theory of motivation is a very complex framework, which considers the brain as the energizer and director of individual's behaviour (Michie et al, 2014). It is based on the principle "At every moment we act in pursuit of what we most desire (want or need) at that moment" (Michie et al, 2014; p. 269). The theory was developed as a patchwork of elements from previous theories, focusing on elements that help explain and predict behaviour (West, 2006; 2009).

As shown in figure 8, there are five subsystems within PRIME, including Plans, Responses, Impulses and Inhibitors, Motives, and Evaluations (Michie et al, 2014). All of the subsystems are influenced by internal and external factors and some of the subsystems influence each other. Based on the theory, Plans – intentions to engage in behaviour - are the most advanced subsystem of motivation (Michie and West, 2013). The next subsystem is Evaluations – beliefs and imagination - which can influence behaviours if they stimulate motives. Next, Motives - feelings of want or need – can influence behaviour. Then, Impulses – which are urge generated from simple reactions and competition between impulses and inhibitors – are the most basic of cognitive functions that influence behaviour. Finally, all of these individual subsystems can lead to behavioural Responses. As depicted in figure 8, to get from the most advanced subsystem to a response it is necessary to go through intermediary less complex subsystems. (Michie et al, 2014)

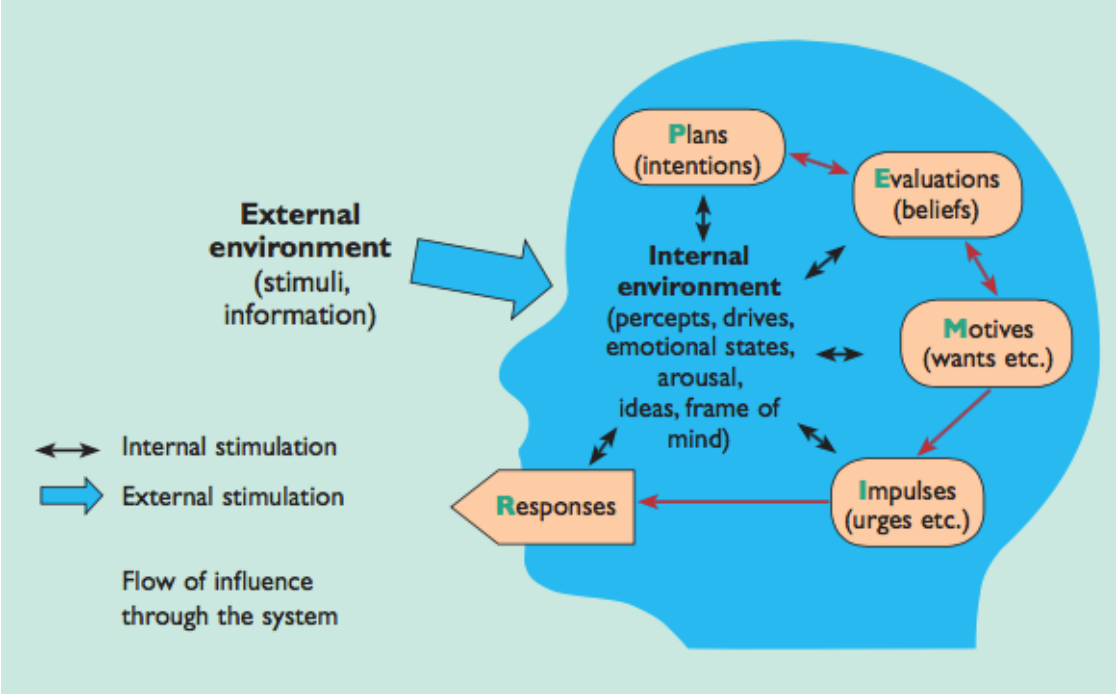

Fig.8. illustrates the relation between the five levels of subsystems of human motivation and external and internal environment. Adopted from McEwen and West, (2010)

Application to general health settings

PRIME Theory has been mainly applied to one behaviour; namely, tobacco use. It has been applied specifically to smoking cessation interventions in conjunction with activities called Behavioural Change Techniques (Michie, Van Stralen, and West, 2011; Michie et al, 2012). Brown et al (2014) conducted an RCT to examine the effectiveness of a PRIME-based smoking cessation interactive webpage as compared to a passive information providing webpage. The authors found that 10% quit smoking for six months in both groups, which is similar to the success rate of one-to-one counselling as found in other studies (Brown et al, 2014).

Ubhi et al. (2015) conducted an observational cohort study to investigate the usefulness of a smartphone app based on PRIME theory and behaviour change techniques to quit smoking (even though it was not clear exactly how this app was created). Approximately 19% of the participants quit smoking for 28 days, so the authors concluded that the app could help certain smokers to quit. Both studies show that PRIME may be effective, but they unfortunately only have short-term follow-ups

and were only applied to online or via apps settings, which can miss populations who are not using apps or online smoking cessation programmes.

Application to oral health settings

PRIME theory has not been applied to specific oral health behaviours including reducing free sugars intake related to dental caries among adults (Al Rawahi, Asimakopoulou, Newton, 2017), although Asimakopoulou and Newton (2015) have suggested that it may be appropriate to apply to do so.

In summary, the PRIME theory of Motivation has not been applied to specific oral health behaviours, and has not been applied to most other health-related behaviours. Because of this lack of evidence-base, more studies are needed before recommendations regarding its application to adult oral health behaviours can be made. Additionally, the theory is limited to mainly motivation and brain processes are energizing and directing behaviour, it can be used in conjunction with COM-B Model (Michie et al, 2014). Because of this, PRIME will not be used for the current line of this PhD Project.

While these theories: The Transtheoretical Model (TTM); Theory of Planned Behaviour (TPB); Information Motivation Behavioural Skills Model (IMB); Social Cognitive Theory (SCT) are the most prevalently used theories, according to Michie and West (2013) they may not be the most effective to capture the full complexity of behaviour change, because of the following limitations:

- Ignore the context where behaviour takes place. For instance, Health Believe Model (HBM) focus on the individual as a key for behaviour change and ignore the other factors such environmental and social which have influence on shaping the behaviour (Ogden, 2004).
- Limited understanding of the causes or drives for behaviours, for instance, TPB assumed that intentions are the drive for behaviours (Ogden, 2004).
- Most of the behaviour change theories are not systematically nor explicitly clear in addressing the ways of bringing the change. For example, TPB does not have a systematic and comprehensive approach toward offering solutions for behaviour change (Ogden, 2004).

- Focus only on motivation aspect of behaviour change without considering other factors; an example of this case is the PRIME theory of Motivation (Michie et al, 2014).

2.4.2.8. Behaviour Change Wheel Framework (BCW)

Background of Behaviour Change Wheel Framework

There are 19 frameworks that were designed and developed as interventions to change; MINDSPACE (an acronym for messenger, incentives, norms, defaults, salience, priming, affect, commitment, and ego) is an example of these frameworks (Michie, Van Stralen, and West, 2011; Michie, Atkins, and West, 2014). However, majority of these frameworks have limitations including the following:

- Most of the frameworks are incoherent and not comprehensive with regard to offering different types of intervention. For instance, MINDSPACE has an incoherent mixture of elements, including modes of delivery (messenger), policy strategies (defaults), and action mechanisms (priming), and does not include crucial, comprehensive types of interventions.
- Insufficient understanding of the nature of the behaviour. For example, Environmental Policy Framework, focuses on social environmental elements as the primarily drive for behaviour with little or no emphasis on beliefs and perception.
- Under-theorized and underused behaviour domain within a framework such as in Intervention Mapping framework.

Based on the limitations of the existing behaviour change theories and intervention design frameworks, a BCW\ framework was developed with the intent to facilitate a comprehensive and systematic means to develop and design behavioural change interventions (Michie, Atkins and West, 2014). The BCW framework takes into account the importance of the contexts in which actions or behaviours take place (Michie et al, 2014). Also, it draws a systematic and coherence plan on how to achieve behaviour change, from understand the behaviour from its context to offering many function interventions and categories and techniques to achieve the behaviour change (Michie et al, 2014; Michie, Atkins and West, 2014).

Key Features

The BCW comprises three layers, as demonstrated in figure 9 and explained below (Michie, Atkins and West, 2014):

- It starts with the inner layer, which is the hub of the wheel and it is used to identify the most proximal determinants of behaviour at the individual or popluation levels. The COM-B (capability, opportunity, motivation, and 'behaviour) model is used for this propose and TDF (Theoretical Domain Framework) can be used for further analysis along with COM-B Model the behaviour.
- The second layer is the intervention functions, which contains a range of functions, which are effective in achieving behaviour change. The application of these functions depends on COM-B Model analysis of the behaviour.
- The outer layer (the rim of the wheel) contains policy categories, which support the delivery of the intervention functions and which modify the context in which individual behaviour occurs.

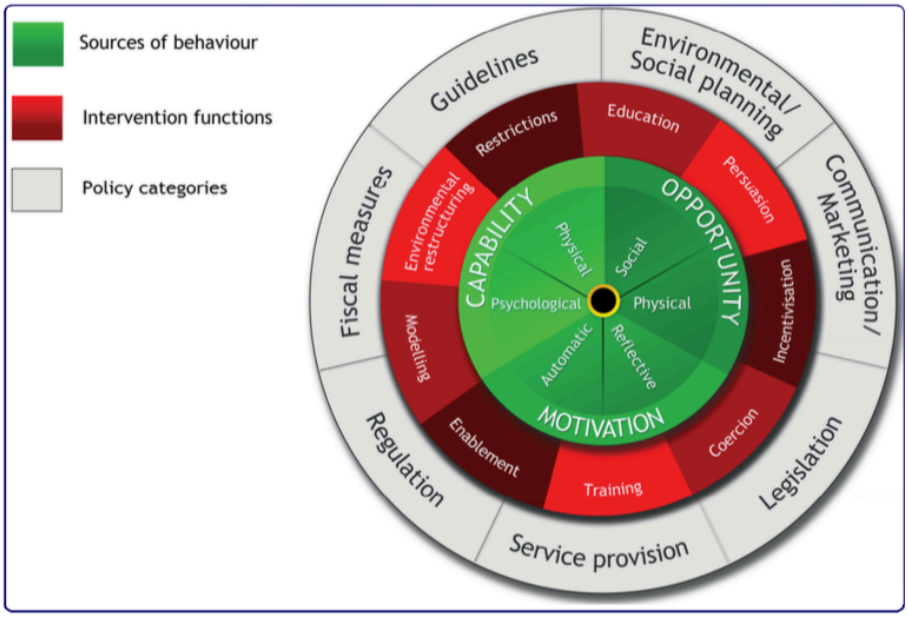

Fig. 9. The Behaviour Change Wheel adopted from Michie, Atkins and West (2014).

Associated Tools

Four initial tools are applied within the BCW framework when designing effective interventions: COM-B Model, Theoretical Domains Framework (TDF), and Behaviour Change Techniques (BCTs), and Mode of Delivery Ontology (MoDO) (Michie, Van Stralen , and West, 2011; Carey, Johnston, Hastings, West & Michie, unpublished). These tools all work together, under the BCW framework, where COM-B Model understanding behaviour, TDF is further analysis of behaviours, BCTs are used to change behaviours and MoDO is used to deliver the Behaviour Change Techniques (BCTs). The relationship between the four tools with BCW is shown in Figure 10. These tools are further discussed below.

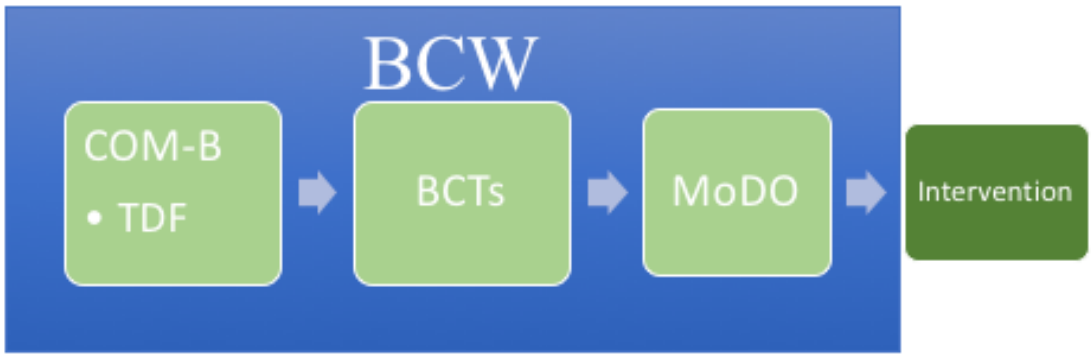

Fig.10. The four tools with BCW and their relation with BCW, designed by Al Rawahi.

COM-B Model

The first tool is the ***COM-B Model*** is used to understand behaviour by providing a "behavioural diagnosis" (Michie et al, 2014). According to COM-B Model, an individual's behaviour is the result of an interaction between three main conditions; the individual's *capability* to perform the behaviour, the *opportunity* that facilitates the behaviour, and *motivation* which energizes behaviour at a given moment (Michie et al, 2014; Michie, Atkins and West, 2014). *Capability* is the ability of individuals to psychologically and physically perform a desired behaviour. The psychological component includes having knowledge of the behaviour and ability to comprehend information and to reason. The physical component includes skills, and strength related to the behaviour. *Opportunity* refers to the external factors that facilitate an individual to perform a behaviour and has two types; namely, physical (created by environment) and social (created by culture). *Motivation* involves brain activities that

energize and direct behaviours and it has two types: automatic motivation (such as habits and emotions) and reflective motivation (such as planning and decision making) (Michie et al, 2014). COM-B Model is a simple but comprehensive model, which is most useful for understanding behaviour, rather than changing behaviour (Michie et al, 2014).

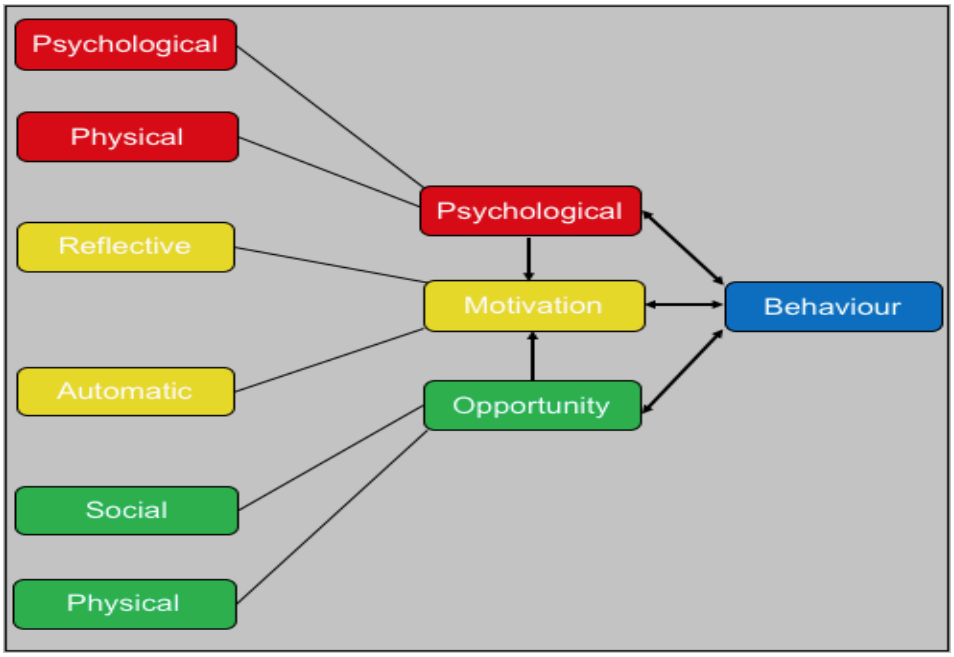

Fig.11. COM-B Model adopted from Michie, Atkins and West (2014) with slight modification by Al Rawahi.

Figure 11 represents the relationship between behaviour and the three primary system constructs. The arrows mean that changing one element of the COM-B Model can result in changing other elements. In other words, decreasing either opportunity or capability can result in decreased motivation and decreased likelihood of engaging in a behaviour (Michie, Atkins and West, 2014). For example, an individual is not motivated *(Motivation element)* to reduce the consumption of high sugary food *(Behaviour element)* because most of the retailers around him have only high free sugars content foods and drinks *(Opportunity element).* The COM-B Model is the model for understanding behaviour because it analyses the behaviour within social and environmental contexts and resources (Michie, Atkins and West, 2014), which play important roles in contributing to the free sugars intake as discussed in the

previous section. With TDF, the understand of the behaviour become more comprehend, as explained below (Michie, Atkins and West, 2014).

Theoretical Domains Framework (TDF)

The second tool is ***The Theoretical Domains Framework (TDF)***, which is a framework consists of 14 domains (constructs) which is used with COM-B model for further analysis of behaviours within their contexts (Atkins and Michie, 2015). It was produced from combining 128 constructs of behaviour and behaviour change theories (Cane, O'Connor and Michie, 2012). Table seven list and define the TDF domains and table eight shows the relation between COM-B model and TDF domains.

Table seven: List TDF domains and their definition adopted from Cane, O'Connor and Michie(2012):

TDF Domain	Definition
Knowledge	(An awareness of the existence of something)
Skills	An ability or proficiency acquired through practice)
Social/Professional Role and Identity	(A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting)
Beliefs about Capabilities	(Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use)
Optimism	(The confidence that things will happen for the best or that desired goals will be attained)
Beliefs about Consequences	(Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation)
Reinforcement	(Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus)
Intentions	(A conscious decision to perform a behaviour or a resolve to act in a certain way)
Memory, Attention and Decision Processes	(The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives)

Environmental Context and Resources	(Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour)
Social influences	(Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours)
Emotion	(A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event)
Behavioural Regulation	(Anything aimed at managing or changing objectively observed or measured actions)

Table eight: present the link between COM-B models constructs with TDF Domains adopted from Cane, O'Connor and Michie(2012)

COM-B component		TDF Domain
Capability	Psychological	Knowledge
		Skills
		Memory, Attention and Decision Processes
		Behavioural Regulation
	Physical	Skills
Opportunity	Social	Social Influences
	Physical	Environmental Context and Resources
Motivation	Reflective	Social/Professional Role & Identity
		Beliefs about Capabilities
		Optimism
		Beliefs about Consequences
		Intentions
		Goals
	Automatic	Social/Professional Role & Identity
		Optimism
		Reinforcement
		Emotion

Behavioural Change Techniques (BCTs)

The third tool is ***Behavioural Change Techniques (BCTs)*** which are activities used to change behaviours and play the dynamic role in interventions (Michie, Atkins and

West, 2014). The Behaviour Change Technique Taxonomy v1 (BCTTv1) consists of 93 techniques clustered into 16-groupings (Michie et al, 2013). This taxonomy provides for intervention designers many choices of techniques for behaviour change; however, it is not simple to select from this huge list without a systematic approach. Therefore, the choice of intervention function is based on 6 criteria: Affordability, Practicality, Effectiveness, Acceptability, Side-effects/Safety, and Equity, which are abbreviated into APEASE (Michie, Atkins and West, 2014). The BCTs can be used alone or in combination; this depends on intervention functions and policy categories of BCW (Atkins and Michie, 2015).

Mode of Delivery Ontology (MoDO)

The four tool is ***Mode of Delivery Ontology (MoDO)*** (Carey, Johnston, Hastings, West & Michie, unpublished) which is currently still under development. The Tool list mode of delivery categories, which is used to deliver the Behavioural Change Techniques (BCTs).

Stages of the BCW framework

The BCW framework suggests eight steps (grouped into three stages) for designing effective interventions for behaviour change (Atkins and Michie, 2015). The first stage is to understand the behaviour, which consists of the following four steps: 1) define the problem in behavioural terms, 2) select a target behaviour, 3) specify the target behaviour for change, and 4) identify what needs to change. The second stage is to identify intervention options, which consists of the following two steps: 5) identify intervention functions, and 6) identify policy categories. The third stage is to identify content and implementation options, which consists of the following two steps: 7) identify behaviour change techniques and 8) identify mode of delivery.

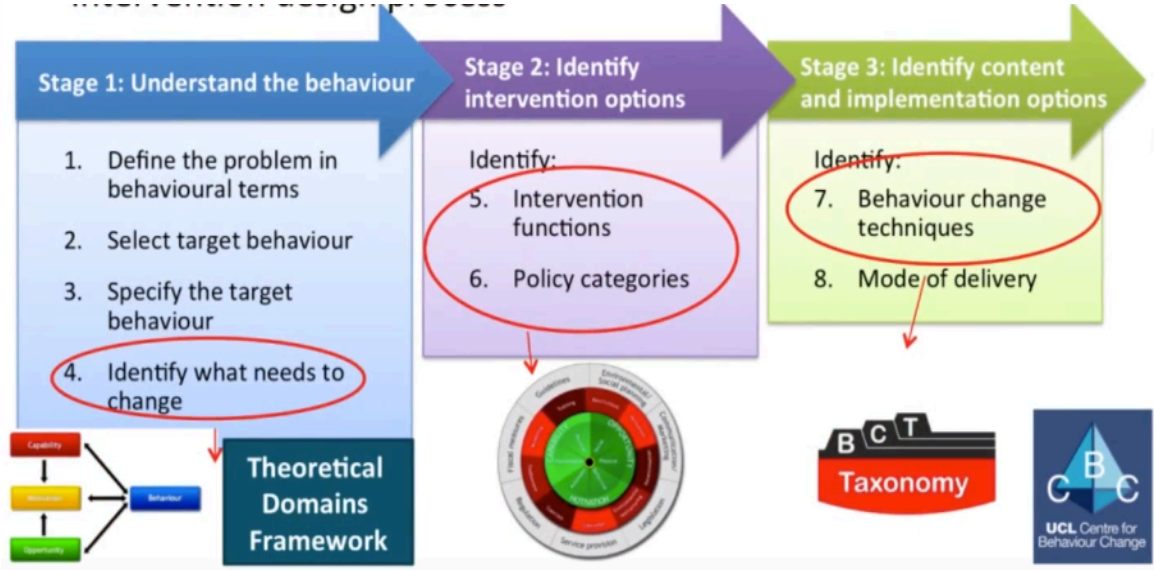

Fig.12. The three stages of Behaviour Change Wheel Framework adopted from UCL Centre for Behaviour Change, (2014)

In summary, the application of the four tools within the BCW system indicates its comprehensiveness and coherence in designing effective behaviour change interventions. Because it tackles behaviour issues from different angles including the context in which the behaviour takes place. Also, the stages are the systematic approach in the BCW framework, which can lead to effective design of behaviour change interventions, because they minimize errors. Unlike other behaviour change theories such as Theory of Planned Behaviour, which does, not have alike steps in designing interventions.

Application to general health settings

The BCW framework provides a system for coding of behavioural interventions and has been utilised within systematic reviews to categorise interventions used to change behaviour and as a system for designing interventions. To date,the BCW has been used as part of systematic reviews in the following fields: head and neck cancer (Govender et al, 2015), research design (Beard et al, 2015), and adherence to medicine related to cardiovascular disease (Laba et al, 2013).

The BCW framework was also used to develop behaviour change interventions for weight management-healthy eating (Curtis, Lahiri, and Brown, 2015; Robinson et al, 2013), rehabilitation (Connell et al 2015), capacity building (Murphy et al, 2014), smoking cessation (Gould, 2014), and men's sexual health (Webster and Bailey,

2013). In general, most authors found that the BCW was a useful theory for designing interventions (Murphy et al 2014; Robinson et al, 2013; Gould, 2014).
However, Webster and Bailey (2013) stated that one of the challenges in using the BCW framework was the difficulty in gathering some data, such as consensus. Also, Curtis et al (2015) felt that the BCW system is not designed for transforming behaviour change plans into software application features, so they had to rely on other sources for selecting appropriate interventions for the purpose of their study. Connell and his colleagues (2015) felt that BCW system was "less directive and helpful" because they believe that any intervention functions and policy categories of the BCW system irrespective to behaviour analysis stage. In addition, the outer layer of the system, which is Policy Categories, is not well defined and fit more under the policy level. This led them to fit all of their intervention components under one-category which is Service Provision. However, they felt that the BCTTv1 was useful in the development of behaviour change interventions because it provided them with common terminology, which helped in describing the aim of each component of the interventions. Unfortunately, none of these studies was a Randomised Controlled Trial. Currently, few trials have been published that aim to test the effectiveness of interventions based on the BCW framework in different health-related behaviours, which are: physical activity (Busse et al 2014; Martin and Murtagh , 2015) and Men's sexual health (Bailey et al 2015).

The ***COM-B Model*** has been used in different fields of medicine and health. It was used in qualitative studies to identify barriers and enablers to behaviour change in areas such as workplace learning (Lloyd et al, 2014), mobilization of vulnerable elders (Moore et al, 2014), intersectoral health collaboration (Hendriksa et al, 2015), paediatric health programs (Alexander, Brijnath and Mazza, 2014), and for increase use of vaccination and antiviral medicines (Rubinstein et al, 2015). Also, the model was used as a framework to develop and design interventions and guidelines to modify health behaviours (Gonzalez- Suarez et al, 2013; Jackson et al, 2014; Lister et al, 2014; Bérubé et al, 2015; Atkins and Michie, 2015) and as a framework within systematic reviews to identify COM-B Model elements (Marie et al, 2013; Arnott et al, 2014). This wide application of COM-B Model is a good indication that the research community is supportive of this theory, and suggests that it is simple but

comprehensive, capturing a wide range of health-related behaviours. Howlett et al (2017) conducted prospective survey among adults to assess the predictive validity of COM-B constructs on moderate-to-vigorous physical activity; two interval points of data collection were made between them a week. The survey was based on questions related to TDF domains. They found that motivation construct of COM-B model was the highest predictor for moderate-to-vigorous physical activity and then physical skills, 77% and 50 % of variance explained respectively. They concluded that motivation is the drive for change. This study could explain the prediction of COM-B Model, however, like other studies the only major limitation of the extant literature is that most of these studies are not RCTs, so further studies are needed to assess the causal relationship between COM-B Model and health-related behaviour change.

The ***Theoretical Domains Framework (TDF)*** has been applied in many fields including: *Exploring problems* such as understanding clinicians' behaviour towards blood transfusion (Francis et al, 2014); surgeons' perceptions towards routine pre-operative testing (Patey et al 2012); and Physician Hand Hygiene Compliance (Squires et al, 2014); *As framework in Systematic review* such as systematic review of barriers to effective management of type 2 diabetes in primary setting (Rushforth et al, 2016); systematic review of guidelines of weight management for pregnant women (Heslehurst et al, 2014) ; *A tool to evaluate service* such as evaluation of failed trial related to CT head application (Curran et al, 2013); *As framework to design Questionnaire* such as Questionnaires for Patient Safety Behaviours (Taylor et al, 2013) and physical activity (Taylor, Lawton, and Conner, 2013); *intervention development* such as development of intervention to modify blunt chest injury management (Curtis et al, 2017). Lipworth, Taylor, and Braithwaite (2013) conducted systematic review assess the implementation of TDF on clinical quality interventions. They found that TDF is strongly related to the application of clinical quality interventions, because the framework has detailed domains that tackle many factors related to "most if not all" clinical quality interventions. Saying that, they are suggestion of possible but not definitely to add perceived trustworthiness domain. From the literature, it can be found that COM-B Model and TDF are promising tools with BCW to change the behaviour in the context of reducing free sugars intake among White ethnic groups in the UK.

Application to oral health settings

The Behaviour Change Wheel (BCW) framework with its tools has not been tested in specific oral health behaviours among adult population including reducing free sugars intake (Al Rawahi, Asimakopoulou, and Newton, 2017). For example, TDF was used to understand factors influence the application of fluoride varnish on Scottish children's teeth (Gnichet al, 2015); factors influence the management of patient with bacterial infection in dental setting (Newlands et al, 2016). Asimakopoulou and Newton, (2015) suggest that the BCW framework and its tools may provide a useful theory for the design of interventions to enhance oral health.

In summary, the BCW system along with its associated tools appear to be the most suitable for capturing the complexity of adult oral health-related behaviours in particular reducing free sugars intake among White ethnic groups in the UK. The previous applications to general settings have demonstrated that it can be successfully applied to design interventions, and to analyse and understand behaviours. Furthermore, it explicitly links behaviour analysis with behaviour interventions (Atkins, Wood, and Michie, 2015). Its usefulness with regard to oral health remains to be explored.

2.5. Motivation for the selecting White Adults

Based on the previously discussed literature, there are three main reasons for selecting adults for the project: high level of caries in adults, and high free sugars intake among adults in particular White ethnic group in the UK. The third reason, which is most of the studies in the field of caries prevention were conducted in children and small number of studies have focused in adults (Moynihan and Kelly, 2014). For instance, Moynihan and Kelly (2014) conducted a systematic review to identify the effect of restricting free sugars intake on dental caries across all age groups. The inclusion criteria of studies were any intervention and observational studies. The findings of included studies in the review were. They identified five studies related to adults and 50 studies related to children; these figures present limited studies conducted in adults (see table one for types of studies and interventions). Their findings are supported by recent systematic review that focused on the impact of sweet beverage on obesity among children and adults (Luger et al, 2017). The included studies in their review

were 20 studies in children and 10 studies in adults. Another example is when typing "guideline for dental caries prevention" on Google search, the first 9 sites listing guidance for children and no on adults. This means more studies and interventions should be also geared to adults.

Table 9. Types of studies and interventions, which were included in the systematic review adopted from Moynihan and Kelly, 2014):

Types of Studies	Studies in Children	Studies in Adults
Non-randomized intervention trials	1	2
Cohort studies	8	0
Population survey	19	1
Cross-sectional studies	22	2

In summary, there is evidence that adults suffer high caries level when compared with other groups. Also, they consume more free sugars than the recommended levels by health professional bodies. Finally, there is evidence of limited studies focusing on adults; based on these evidences there is a need to gear behaviour change interventions to adults' population in particular White ethnicity.

2.6. Conclusion

This literature review set out to discuss many topics related to free sugars intake and applications of six psychological theories and frameworks. It's evident from the research that high fre sugars intake contributes to many general and dental diseases and there are many factors contribute to high free sugars intake. Also, it was evident that adults consume more free sugars then the recommendation. In particular, White ethnic groups and there are limited studies that focus on comparisons of adult and child populations. Also, from this literature review researches have shown some

predictor to the consumption of free sugars intake, however, these studies had limitations where the theories did not account other major contributors to high free sugars intake including environmental factors. Therefore, a suggestion to use more comprehensive and systematic theories to identify predictors to free sugars intake. Different preventive actions can be used to minimise the risk of dental caries thought free sugars intake including: the use of fluoride and sugary diet control. It is evident that fluoride application alone can decrease dental caries but it alone cannot eradicate caries unless other measures are adopted, in particular reducing the intake of free sugars. Along with oral health actions 8 general actions based on some evidence were suggested by PHE (2015) that could help in reducing free sugars intake at the population. However, some concerns if these 8 actions were developed from theory-based approach; because there is some evidence which suggest that interventions based on theory could be more effective when compared without theory based approach. There is some evidence that oral health education does not have influence in diet control behaviour, accept increase knowledge. In contrast, theory based approaches can be more effective in designing interventions to reduce free sugars intake. Six Theories of behaviour change and a framework were summarized their key features: The Transtheoretical Model of Change, Social Cognitive Theory, Theory of Planned Behaviour, Information-Motivation-Behavioural-Skills Model, PRIME Theory and Behaviour Change Wheel. Additionally, the review included the available evidence of the theories and models in, terms of their application in general and oral health settings. From the evidence, it is clear that Social Cognition Models have limited evidence to achieve behaviour change for individuals e.g. TTM and TPB, but they there is moderate evidence for them to predict some behaviours. For COM-B, TDF and BCW there is hope that they might be found to be more effective in changing behaviour, because of the comprehensiveness they provide, however the evidence about their use in oral health is limited at the moment. Also, there was some evident from the literature individual constructs could enhance the reduction of free sugars consumption including: self-efficacy and Action planning.

While interventions based on psychological theory are accepted to be more effective than interventions not based on theory, it is unclear at present which theory is the best to choose as a basis for the design of interventions for sugars consumption behaviours. Furthermore, while the individual constructs within any model may be

strongly related to a behaviour in cross sectional studies, this does not necessarily mean they are suitable targets for behaviour change interventions, since they may not be amenable to change or because of the direction of causality (for example behaviour change may result in change in attitudes rather than the reverse). There is a need for better-designed trials of interventions based on the clear operationalisation of psychological constructs to reduce free sugars intake. Furthermore, there is an existing gap in the literature concerning the application of the COM-B, TDF and BCW framework to free sugars intake related dental caries in adults. This is an opportunity for further studies, which will comprise the main research project of the PhD.

Theory based interventions have been developed for other oral health related behaviours such as toothbrushing, flossing alcohol intake, smoking cessation etc, however these have not been tested in free sugars intake which has a degree of complexity in that since free sugars can be hidden in foods it is often not volitional (as compared to toothbrushing, flossing and alcohol intake) and it does not have an addictive overlay compare with smoking cessation. Also, the factors contributing to free sugars intake are not the same as other behaviours and it was evident from the review that interventions might work well on a behaviour, but it might not work well on other behaviours. Therefore, we felt it important to explore a free sugars cessation specific intervention.

However, before attempting to conduct any further studies related to the application of the BCW system to free sugars intake related dental caries among adults, there is a need for a comprehensive review of papers related to the application of theories and models of behaviour change to free sugars intake related dental caries in adults. This is because the current review does not address such quality assessment of all relevant articles and misses other behaviour change models. Therefore, the next step, which is beyond the scope of this review, is to conduct a systematic review of interventions based on behaviour change theories and models, which aim to improve dietary behaviour related to dental caries among adults.

3. PhD Project Aims:

3.1. To systematically review interventions based on psychological models and theories that aim to reduce free sugars intake related to dental caries in adults.

3.2. To identify facilitating factors and barriers to the new recommendations of reducing free sugars intake (WHO, 2015) to less than 5% of the total energy among White British adults in the UK by using COB-M model and Theoretical Domain Framework TDF (Michie, Atkins and West, 2014).

3.3. To develop a questionnaire from the qualitative interviewing (aim 3.2) that can help to examine the association between reducing free sugars predictors based on TDF and COM-B model (Michie, Atkins and West, 2014) and the consumption of free sugars White British adult groups in the UK.

3.4. To examine the association reducing free sugars predictors based on TDF and COM-B model (Michie, Atkins and West, 2014) and the consumption of free sugars White British adult groups in the UK. This This could help in planning for to future clinical trials which aim to reduce free sugars intake.

4. Study One: Theory based interventions for caries related free sugars intake in adults: Systematic review

Registered Protocol: PROSPERO: CRD42015026357

4.1. INTRODUCTION

Theories of behaviour change are essential in the design of effective behaviour change strategies (Davis et al, 2015; Munro et al, 2007; Ogden, 2004; Forshaw, 2002). Such theories can be helpful in improving our understanding of how behaviour change might lead to a healthy lifestyle (Davis et al, 2015; Munro et al, 2007; Ogden, 2004). Interventions based on such models have been shown to predict behaviour change better than non-theory-based interventions (Abraham et al, 2009).

Social Cognition Models (SCMs) are a subgroup of psychological theories, which are based on the assumption that the individuals' attitudes and beliefs towards a behaviour are strongly predictive of the likelihood of them engaging in that behaviour (Newton and Asimakopoulou, 2015). Interventions based on such models have been shown to improve dietary behaviours related to general health in highly selected patient groups. For example, Stacey and his colleagues (2015) conducted a systematic review and meta-analysis to assess the effectiveness of physical activity and dietary change interventions based on Social Cognitive Theory among individuals who had survived a cancer diagnosis. The study showed that most of the included interventions were effective for enhancing dietary behaviour and physical activity. The authors, concluded that interventions based on psychological theories are effective in changing behaviour.

In oral health, two comprehensive systematic reviews have been conducted to assess the effectiveness of interventions based on SCMs, which aimed to improve adherence to oral hygiene related behaviours in adults with periodontal diseases. In the first systematic review, Renz and colleagues (2007) reported that the low quality of studies associated with SCTs, made it difficult to draw any conclusions about SCT model efficacy. In the second systematic review, Newton and Asimakopoulou (2015) identified that self-efficacy, goal setting, and planning were the most effective constructs for improving oral health behaviour in periodontal patients. This suggests

that at least some components of SCMs may be effective for predicting oral health behaviors regardless of the overall theoretical framework which they were part of (Newton and Asimakopoulou, 2015).

However, upto date there is no published systematic review of the effectiveness of interventions based on psychological models of health related behaviour to reduce free sugars intake related to dental caries in adults. Dental caries is a prevalent issue that affects the majority of the adult population around the world [White et al, 2009; Maru and Narendran, 2012; Vos et al, 2012); for instance, in the US more than 84% of adults have some caries experience (NIDCR, 2014) and the average Decayed, Missing, Filling Tooth (DMFT) score of adults in the UK of adults aged between 35 and 44 year olds is 11.57 (Bernabé, and Sheiham, 2014a; 2014b). On the basis of a systematic review, Moynihan and Kelly (2014) concluded that reducing daily free sugars intake to less than 10% of total energy would reduce the prevalence of dental caries; a further reduction to less than 5% may prevent the progression of dental caries in the long-term. The relationship between free sugars intake and caries remains strong even with the application of fluoride as a preventive strategy (Moynihan and Kelly, 2014), emphasizing the importance of lifestyle interventions to reduce free sugars intake.

Achieving the target consumption of free sugars is likely to require behaviour change by individuals, and the dental team can play an important part in assisting people to achieve this. The aim of the current systematic review is to examine the effectiveness of interventions based on Social Congitive Models (SCMs), aimed at reducing free sugars intake related to dental caries among adults. The review aims to rectify this by addressing the following question: What is the effect of interventions based on Social Congitive Models (SCMs) on free sugars intake in adults, when compared with educational interventions or no intervention?

4.2.METHOD

The current systematic review was registered with the International Prospective Register of Systematic Reviews (PROSPERO), 2015 database (CRD42015026357). The reporting of the review is based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) (Moher et al; 2010).

Eligibility criteria:

- ***Types of studies***
    - Systematic Reviews with or without Meta-Analysis
    - Randomised Controlled Trials
    - Controlled Clinical Trials
    - Before and after studies
- ***Types of interventions***

This review included interventions based on the following psychological theories and models of health related behaviour:

- Health Belief Model (HBM)
- Theory of Reasoned Action (TRA)
- Theory of Planned Behaviour (TPB)
- Self-Efficacy Model
- Transtheoretical Model (Stages of Change)
- Protection Motivation Model
- Health Locus of Control (HLOC)
- Implementation Intentions
- PRIME (Plans, Responses, Impulses, Motives, Evaluation) Theory of Motivation
- Unrealistic Optimism Bias
- Self-Regulatory Model
- Health Action Process Approach (HAPA)
- Precaution Adoption Process Model (PAPM)
- Outcome Expectancy
- Hypothesis Model of Compliance
- Social Cognitive Theory
- Information Motivation Behaviour Skills Model (IMBM)
- Operant and Classical Conditioning
- Interventions adopting techniques from Cognitive Behaviour Therapy
- Motivational Interviewing
- COM-B (Capabilities, Opportunities, Motivations, Behaviour) Model
- Behaviour Change Wheel (BCW)

- Papers were included if they clearly stated that one of the above psychological

models or theories was used and at least one construct identified in the theory or the model was targeted in the intervention.

- Sugars were defined "as any of: total sugars, free sugars, added sugars, sucrose, non-milk extrinsic (NME) sugars, expressed as g or kg /day or /yr or as percentage E." (Moynihan and Kelly, 2014; p.1)
- ***Comparison:*** oral health educational (non-psychological theory based) interventions, or no intervention controls.
- ***Types of participants***
    - Adults aged 18 or over.
    - Patients with or without dental caries. For the aim of this review, dental caries is defined on the basis of diagnosis from a dental clinician. This includes diagnoses of any caries lesion active, progressive or arrested, which includes root caries.
- **Outcome measures:**

  Three outcome measures were considered to determine adult's oral health related behaviours for this review (Michie, and Abraham, 2004).
  - ***Behavioural outcomes***: reduction of free sugars intake, assessed by any method, including self-report, food diary, observation etc.
  - ***Attitude and belief outcomes:***
    - *Primary outcomes:* Patients' attitudes, beliefs and their intentions towards free sugars intake related to dental caries.
  - ***Clinical status outcomes****:* Progression of dental caries in the permanent dentition, assessed via tooth decay increment: DMFS (Decayed, Missing, Filling, Surface) and/or DMFT scores; filled teeth including replaced restorations; early carious lesions which are arrested or reversed; root caries.

Information sources

- The Cochrane database including: Oral Health Group's Trials Register (2015),
- MEDLINE (from 1966 to September 2015),
- EMBASE (from 1980 to September 2015),
- PsycINFO (from 1966 to September 2015).

The search included reference lists from relevant articles and the eligible authors

of trials were contacted for additional information if necessary. The search was not restricted to a particular language.

Search

A detailed search strategy was developed from Medline. An information specialist was consulted to assist with the development of the search strategy, as previous research suggests this improves the quality of the search (Higgins and Deeks, 2008) This search strategy was amended accordingly for use on each of the other selected databases. MeSH (fixed vocabulary) and free text terms will be used to conduct the search strategy. Appendix one lists the search terms, which were adopted.

Study selection

Two authors (S Al and JTN) conducted the search and assessed the studies, initially through evaluating titles, keywords, and abstracts. Any articles, which were not considered to be suitable, were rejected at this stage. Full reports of studies were retrieved for all studies if they met the inclusion criteria. Further full review was conducted if the studies met the inclusion criteria for full assessment. Any potential differences in inclusion of a study between the two authors, it was determined by referred to a third reviewer (KA) for her opinion in the inclusion. However, third reviewer was involved in reviewing the systematic review report to ensure that inclusion was made appropriately to the PRISMA guidelines. Figure one illustrates the process of study selection based on Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flowchart (Moher et al; 2010).

Data collection process

Data were collected for each study on a data sheet, which includes the following data points:

- Study Design
- Sample size
- Psychological constructs assessed and theoretical framework adopted
- Measures of primary and secondary outcomes
- Effect of intervention on outcomes

Two authors (JTN and SAL) independently extracted the data, following the guidance of the Cochrane reviewers' handbook checklist (Higgins and Deeks, 2008).

Risk of bias in individual studies

The Cochrane reviewers' handbook checklist was to be used (Higgins, Altman, and Sterne, 2011) to assess the risk of bias interventional trials.

Synthesis of data

A meta-analysis was planned if a sufficient number of homogeneous studies met the inclusion criteria.

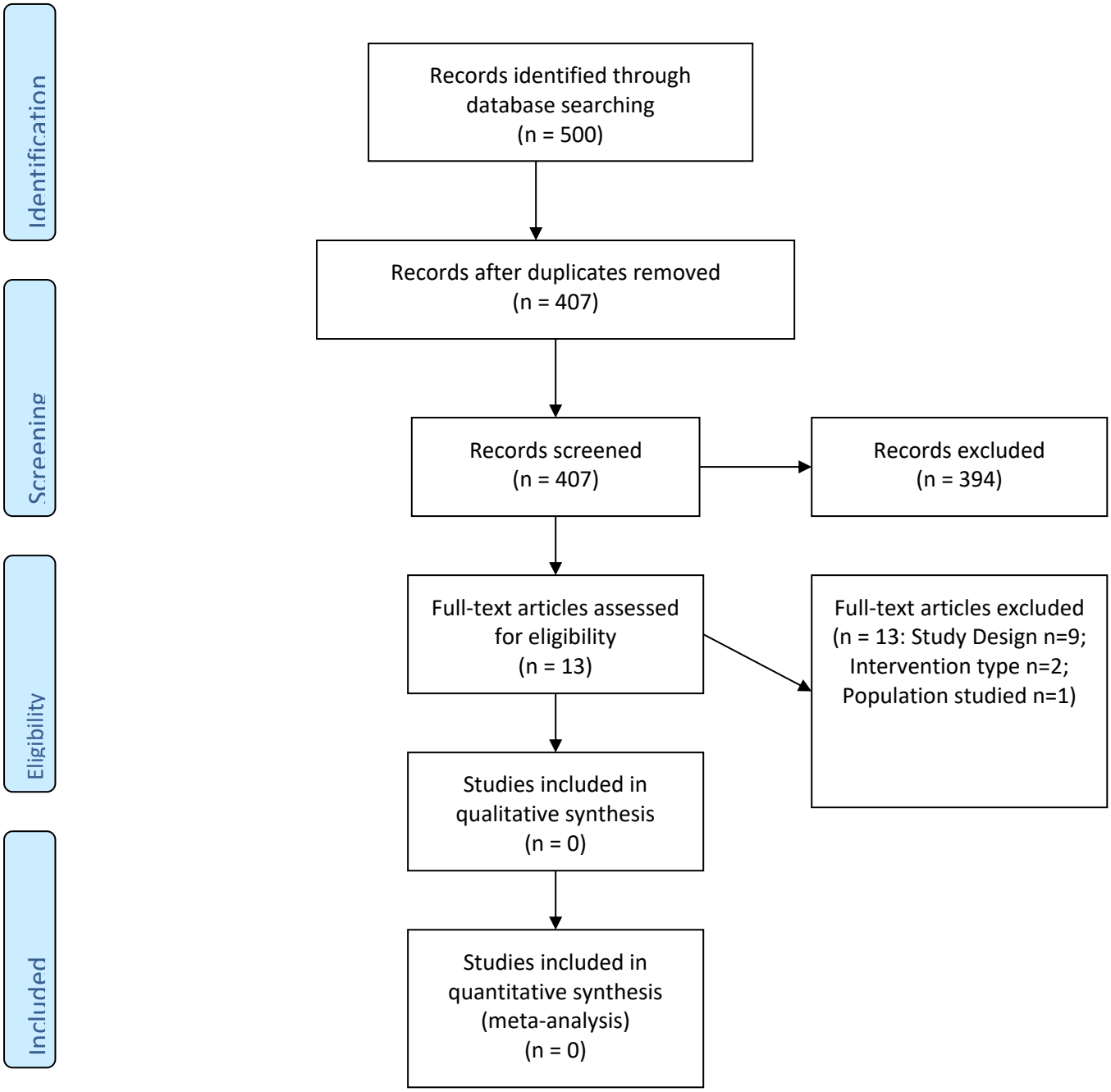

Figure 13. Systematic Review Flowchart.

4.3.RESULTS

Description of studies

Initially, the search strategy identified 500 articles (see Figure 13- Systematic Review Flowchart). After exclusion of duplicates, the titles and abstracts of 407 articles were screened for relevance. At this stage 13 papers were apparently relevant being related to dentistry and having applied psychological models and theories to develop the reported intervention. However, after obtaining the full manuscripts no article met the full eligibility criteria for the current systematic review. Table 10 provides the characteristics of the excluded studies.

Risk of bias and Data Synthesis:

Given that there were no papers meeting the criteria for the review, risk of bias and synthesis of data were not conducted.

Table 10: Characteristics of excluded studies:

Reference	Paper Title	Participants	Study Design	Psychological Model	Reasons for exclusion
Reisine et al. (1994)	A biopsychosocial model to predict caries in preschool children	Children & parents	Cross-sectional survey	None specified	Cross-sectional study
Astrøm & Rise (1996)	Analysis of adolescents' beliefs about the outcome of using dental floss and drinking non-sugared mineral water.	Adolescents	Cross-sectional survey	None specified	Cross-sectional study and participants were adolescents
Astrøm, Awadia & Bjorvatn (1999)	Perceptions of susceptibility to oral health hazards: a study of women in different cultures.	Adults	Cross-sectional survey	None specified	Cross-sectional study

Roberts, Blinkhorn & Duxbury (2003)	The power of children over adults when obtaining sweet snacks.	Children & parents	Cross-sectional survey	Theory of Reasoned Action	Cross-sectional study
Adair et al. (2004)	Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economically diverse groups.	Children	Cross-sectional survey	Theory of Planned Behaviour, Health Belief Model and the Health Locus of Control	Cross-sectional study and participants were children
Astrom (2004)	Validity of Cognitive Predictors of Adolescent Sugar Snack Consumption.	Adolescents	Cross-sectional survey	Theory of planned behaviour	Cross-sectional study and participants were adolescents.
Astrøm AN, & Okullo I., (2004)	Temporal stability of the theory of planned behaviour: a prospective analysis of sugar consumption among Ugandan adolescents.	Adolescents	Cross-sectional survey	Theory of planned behaviour	Cross-sectional study
Skeie et al, (2006)	Parental risk attitudes and caries-related behaviours among immigrant and	Children & parents	Cross-sectional survey	Theory of planned behaviour, Social learning theory	Cross-sectional study

	western native children in Oslo.			and the Health Belief Model. Health Locus of Control	
Astrøm & Kiwanuka (2006)	Examining intention to control preschool children's sugar snacking: a study of carers in Uganda.	Children	Cross-sectional survey	Theory of planned behaviour	Cross-sectional study and participants were children
Vanagas et al. (2009)	Associations between parental skills and their attitudes toward importance to develop good oral hygiene skills in their children.	Adults	Cross-sectional survey	Theory of Planned Behaviour, Health Belief Model and the Health Locus of Control model,	Cross-sectional study
Tolvanen et al. (2009)	Changes in children's oral health-related behaviour, knowledge and attitudes during a 3.4-yr randomized clinical trial and oral health-promotion program.	Children	RCT	None specified	Participants were children and no Social Cognition Models identified

Harris et al. (2012)	One-to-one dietary interventions undertaken in a dental setting to change dietary behaviour.	All ages	Systematic Review (S.R)	None specified	No Social Cognition Models identified
Weber-Gasparoni et al. (2013)	An effective psychoeducational intervention for early childhood caries prevention: part 1	Children & parents	RCT	Self-determination theory (SDT)	Participants were children
Weber-Gasparoni et al. (2013)	An effective psychoeducational intervention for early childhood caries prevention: part 2	Children & parents	RCT	Self-determination theory (SDT)	Participants were children

4.4.DISCUSSION

This review sought to assess the effectiveness of interventions based on social cognition models (SCMs) to reduce free sugars consumption among adults. The review focused on an often neglected area of health psychology that of oral health. No studies were found that matched the inclusion criteria of the review.

There is a dearth of intervention studies designed to explore the effectiveness of psychologically based interventions on oral health including oral hygiene as well as diet related behaviour. Harris and his colleagues (2012) examined the effectiveness of one-to-one dietary interventions for dietary behaviour among all age groups in dental settings. They identified five studies, none of which included the modification of constructs identified from psychological models of behaviour. Similarly, Renz et al

(2007) and Newton and Asimakopoulou (2015) located very few trials of interventions to enhance oral health related behaviours (toothbrushing and flossing) based on psychological theory, echoing calls for more and better-designed trials (2010). Whilst it is disappointing that no intervention studies based on psychological theoretical models were identified from our systematic search, the current review has confirmed the need for high quality, theory-driven interventions to support clinical practice and has highlighted potential opportunities for researchers and intervention designers to explore and examine such approaches.

4.5.CONCLUSION

To date there has been no published study of the effectiveness of interventions based on Social Cognition Models (SCMs) aimed at reducing free sugar intake related to dental caries among adults. Given the contribution of dietary free sugars to caries development and the role of lifestyle change to combat dietary free sugar intake, there is a need for trials of theory-based interventions aimed at reducing individuals' consumption of dietary free sugars.

Ethics approval and consent to participate

Not applicable

Consent for publication:

Not applicable

5. Process of Understanding Free Sugars Intake Among White British Ethnic groups in the UK

It is evident from the previous study which is systematic review, that there is a need for trials of theory-based interventions aimed at reducing individuals' consumption of dietary free sugars. Also, from the literature review, there evidence that suggests BCW framework and its' tools including COM-B Model and TDF are the most promising framework for behavioural change because (Atkins and Michie, 2015):

- Identifying the needs for behaviour change through understanding the behaviour from different aspects including the contexts.
- Building and gathering the evidence in a systematic and comprehensive approach
- Identifying the mechanism of actions for achieving behaviour change.
- Providing alternative intervention options

Also, it is evident from the literature that there is a need to change White British adults' behaviour related to the intake of free sugars, because their high consumption of free sugars is more then the other groups and WHO (2015) and PHE (2015) recommendation. Also, the population were chosen because of limited studies aim to understand the population (Moynihan, and Kelly, 2014; Al Rawahi, Asimakopoulou, and Newton, 2017). The BCW Guide book (Michie, Atkins and West, 2014) suggests three main stages for behaviour change interventions development which has been described in the literature review section. As for this PhD project, it will focus on the application of first stage on White ethnic British in the UK which is understand the behaviour of free sugars intake related to the targeted groups. Possibly make some future suggestions about the next two stages of the BCW related to reducing free sugars intake towards the end of the project. In the first stage of BCW there are four steps. *The first step to define problem in behaviour terms.* From the literature, the problem would be the high intake of free sugars among adults in the UK. *The second step is to select the target behaviour. The third step is to specify the behaviour targeted for change.* These specific details will help in understating the behaviours.

The Fourth step is to identify what needs to change. Steps two to four will be achieved through the application of COM-B Model and TDF. Both tools will help in understanding facilitating factors and barriers to the application of the new free sugars intake recommendation (WHO, 2015) among White British adults in the UK. This would involve the analysis of adults' capability, opportunity, and motivation and TDF through qualitative and quantitative research designs. This is called a mixed method in which a combination of the qualitative findings with quantitative findings together would result in richer data; this was suggested by Atkins et al. (2017). The next section, discusses the mixed method approach.

6. Mixed Methods Research

This section addresses the following points: definition of mixed methods research, benefits of the method, typology of mixed method research dimension of selecting the mixed method design, analysis and relates each of these points to the current PhD project.

6.1. What is Mixed Method Research?

The mixed methods approach can be defined in broad terms as, *"the combination comes from least one qualitative and at least one quantitative component in a single research project or program"* (Bergman, 2008; p.1). Creswell, and Plano Clark (2018) argued that such a definition is limited and there are characteristics which actually define the mixed methods research. They define important characteristics for mixed methods: quantitative and qualitative data are thoroughly collected and analysed based on hypotheses and research questions (Creswell and Plano Clark, 2018). Also, they add that the data and their results are integrated (or mixed or combined). Moreover, all these procedures are organized into specific research designs which *"provide the logic and procedures for conducting the study, and frames these procedures within theory and philosophy"* (Creswell and Plano Clark, 2018; p.5). The definition of Creswell and Plano Clark, (2018) for mixed methods research illustrates different examples of the method applied in different field and provides a comprehensive picture of the mixed methods and their typologies.

Multi-methods research or multiple methods are sometimes used in-conjunction or interchangeable with the mixed methods research, however, the multi-methods approach is different from mixed methods (Morse,2010). The multi-method is a research method where a research collects multiple types of quantitative data or qualitative data to answer the research question; this is different from mixed method (Creswell and Plano Clark, 2007). In fact, researchers of the projects funded by National Institute of Health claimed that most of the time they used multi-method, however they used only 64% of time this method and 36% used mixed methods (Creswell, 2011). This indicate that there is some confusion between the two methods.

Based on the remarks of Creswell and Plano Clark, (2007; 2018), this PhD project applied the mixed methods approach to achieve the aim of the project. Furthermore, Atkin et al (2017) encouraged the use of mixed method when applying COM-B and TDF to enhance the quality of the research and best employ of the TDF and COM-B model.

6.2. What are the advantages of applying Mixed Method Research?

Creswell and Plano Clark, (2018) identified many benefits. First, the mixed method approach, allows the use of different and multiple techniques and methods which could better address the research question than a single method. This leads to the other benefit of using mixed method that it answers research questions that a single method alone could not answer. Second, the method encourages the use of numerous views of different background and interdisciplinary teamwork. Third, the use of mixed method offers a compensation mechanism which mean that a strength of one method compensate the weakness of the other one; this leads to more persuasive and comprehensive evidence.

For this PhD thesis the benefits of using mixed methods are: more comprehensive and convincing evidence; this is based on the guidelines of Atkin et al (2017). Compensation mechanism, for example the sample size of qualitative interviewing was limited in number 27 participants, so it was compensated with online survey to achieve more sample size to 200 participants. The different aims of this PhD necessitate a mixed methods approach, for example, the aim related to participants' experience and opinion needs qualitative approach to achieve it. The aim determing the extent to which the TDF and COM-B model predict free sugars intake requires a quantitative approach to achieve the aim.

6.3. What are the Typologies of Mixed Method Research?

Different typologies (classifications) of mixed method research have been proposed over time (Guest and Fleming, 2015). The typologies were developed to describe the means by which quantitative and qualitative methods fit together in a research project (Guest and Fleming, 2015). There are around 15 different types of typologies developed (Creswell and Plano Clark, 2018), these including: Morgan's (1998) Four-Quadrant Typology; Morse and Niehau's (2009) Eight Design Types; Teddlie and

Tashakkori's (2009) Five Families of Mixed Method Designs and the latest one is for Creswell and Plano Clark's (2018) seven mixed method designs. Creswell and Plano Clark's (2018) seven mixed method designs has been selected to describe them, because the typology is the latest and easy to follow. There are Creswell and Plano Clark's (2018) seven mixed method designs which are: Convergent; Explanatory Sequential; Exploratory Sequential; Mixed Methods Experimental; Mixed Methods Case Study; Mixed Methods Participatory-Social Justice; Mixed Methods Evaluation. Table 11 define each of the seven designs developed by Creswell and Plano Clark's (2018). For this PhD thesis, the author applied Exploratory sequential design, because the one of the purposes of the qualitative study is to use its finding to inform the development of online survey, which is more appropriate and recommended by Atkin et al (2017).

Table 11: Define the Creswell and Plano Clark's (2018) seven mixed method designs

Mixed method designs	Definition
Convergent design	Qualitative and quantitative data are collected simultaneously but analysed separately as the two databases. After that the findings from two databases are then merged or compared. In this design both Qualitative and quantitative data are prioritized, **however, the prioritization would vary purpose of the study.**
Explanatory Sequential design	Quantitative data are collected and analysed , and the results are used to inform the follow-up qualitative data collection. The collections of quantitative and qualitative data are not independent, but they are relative to each other.
Exploratory Sequential Design	Qualitative data are collected and analysed, and then the findings are used to develop quantitative materials and then a follow-up quantitative phase is conducted through data collection and analysis. Creswell and Plano Clark's (2018) call it "three-phase design—qualitative-quantitative-quantitative"

Mixed Methods Experimental Design	Qualitative data are embedded within an experimental trial. The collection of the data can be either before, during, or after the experiment (or intervention), or even multiple times.
Mixed Methods Case Study Design	Quantitative and qualitative data are collected as evidence for a case(s) or to create a case(s) and the data is embedded within the structure design of the case.
Mixed Methods Participatory-social Justice	A core mixed methods design is enclosed within a participatory or social justice framework. the qualitative and quantitative are collected and proceeded either convergent or sequential, or both.
Mixed Methods Evaluation Design	In this design, sequential and convergent strands are combined over a period of time within the process of evaluation which is designed to assess the application of an intervention strategy.

6.4. What are the dimensions of selecting Mixed Method Design?

The selection and planning of the mixed method design depend on the three common dimensions, which are integration timing, weighing (Dominance), and purpose (Guest and Fleming, 2015). The *Integration time* meant by the chronological application and analysis of the data from the quantitative and qualitative (Guest and Fleming, 2015). There are two types of Integration time: concurrent and sequential designs (Guest and Fleming, 2015). The *concurrent design* (symbolized by plus +) means the collection and analysis of the quantitative and qualitative data take place at the same time; the data don't depend on another one. Contrary, the *sequential design* (symbolized by arrow →) means the integration of the data collection and analysis of one method take place chronologically so to inform or explain the design of dataset for the second method. This means that the last data analysis and collection depend on the first or previous data analysis and collection (Guest and Fleming, 2015). Further, the sequential design there are two types: *exploratory* where findings from one dataset are used to inform the next dataset (e.g. finding from qualitative data are used to inform in the design of quantitative tool); *explanatory* is the use of one dataset to explain the

findings gained from another dataset (e.g. qualitative data used to explain the findings from quantitative) (Guest and Fleming, 2015). In this PhD project the integrated time applied is exploratory sequential design, because the study number four (quantitative survey) is depending on the findings from study number 2 (qualitative interviewing) and the findings from the qualitative interviewing are used to inform the quantitative survey.

The other dimension for selecting mixed method design is *the dominance* (symbolized by UPPER CASE), which is priority is given to a methodology applied in the mixed method by the researcher (Guest and Fleming, 2015). Guest and Fleming, (2015) explained that, the less dominant (symbolized by lower case) method means that it is not the central for data collection and analysis in the research and is not the main theme when writing-up the finding of the study. They also, added that the less dominant is important to objectives of the projects. The dominance in the mixed method could be equal between the two methods or one is more dominant then the other one (Creswell and Plano Clark, 2018). In the case of this PhD project, both qualitative and quantitative are equal dominant (priority) because the qualitative methods helped to identify factors contribute to reducing free sugars intake and the quantitative methods helped to inform intervention design. Both are impotent in the Behaviour Change Wheel intervention framework. A notation for the mixed method of this PhD project will be QAUL→ QUAN

The last dimension is the purpose or aim of the research, which gear the use of mixed method. The aims of this PhD Project required the use of exploratory sequential design.

6.5. Analysis in Mixed Method Research

There are three types of analysis in the mixed method research and are associated with integration process: parallel data analysis, concurrent data analysis and sequential data analysis (Östlund et al., 2011). The parallel data analysis means that the collection and analysis of the qualitative and quantitative data takes place at the same time, the integration between the two data is achieved during the interpretation phase of the data (Östlund et al., 2011). The concurrent data analysis is similar to the parallel analysis, but the integration of the data takes place during the analysis stage, to quantify the qualitative data or qualitise the quantitative data (Onwuegbuzie and

Teddlie, 2003). In contrary, the sequential data analysis, is not done for the purpose of integration, it is done in sequential order (two phases) for the purpose of findings in phase one to inform or use in the methods of phase two (Onwuegbuzie and Teddlie, 2003). This PhD project applied sequential data analysis because it applied Exploratory Sequential design.

6.6. Summary

In summary, mixed method research is useful method that can answers more complex research questions. There are different mixed method designs can be used, however, this depends on three main dimensions: Integration time, dominance and the purpose of the research project. The analysis of the mixed method research depends on the design of the mixed method research. The application of exploratory sequential design in this PhD project would make the findings relevant to White British adults; leading to predict appropriate and effective intervention to reduce free sugars intake among the group. The section below describes the application of exploratory sequential design in this PhD project

6.7. Application of the Mixed method in this PhD research

Studies two, three and four of this PhD research in the collective form is called a mixed method research, where the research starts with qualitative methods in the study two and ending with quantitative method in in the study four; study three is a transformation hub from qualitative to quantitative data collections. The second study which qualitative interviewing was used to collect White British adults' opinions and experience on barriers and facilitator to reduce free sugars intake. In third study, a first draft of the survey was made based on the participants' opinions and experience and it was review by expert academics from the university. After that a second draft was made and was piloted to 20 British White adults think-Aloud and verbal probing approaches for feedback in terms of the online application and content. Then a third and final draft was made after the feedback from the 20 participants and was review by academic expert. The fourth study was carried out using the fourth and final draft of the questionnaire online. Reliability test was carries out and relevant statistical test. Details of the three studies are discussed in the next sections.

7. Study Two: Factors Related to Reducing Free Sugars Intake Among White Ethnic Adults in the UK: A qualitative study

7.1.INTRODUCTION

The rate of free sugars intake among adults in the UK, however, is consistently higher than the WHO recommendations which consumption of less than 10 % per of the total intake per day (WHO, 2015). According to the National Diet and Nutrition Survey UK (Bates et al, 2014), the free sugars intake among adults aged 19 to 64 years old is 12.1% of the total energy intake, and the free sugars intake for those over 65 years is 11.5% of the total energy intake. In addition, the free sugars intake of most ethnic groups in the UK exceeds the goal of less than 5% of total energy intake; however, the Defra report (Department for Environment, 2014a; 2014b; 2015a; 2015b; 2017a; 2017b; Leung and Stanner, 2011) indicates that people who identify their ethnicity as White have the highest free sugars intake compared with other ethnic groups in the UK. Figure 14, illustrates White ethnic groups in the UK consumed more free sugars than any other groups during the last three years (2011-2013),

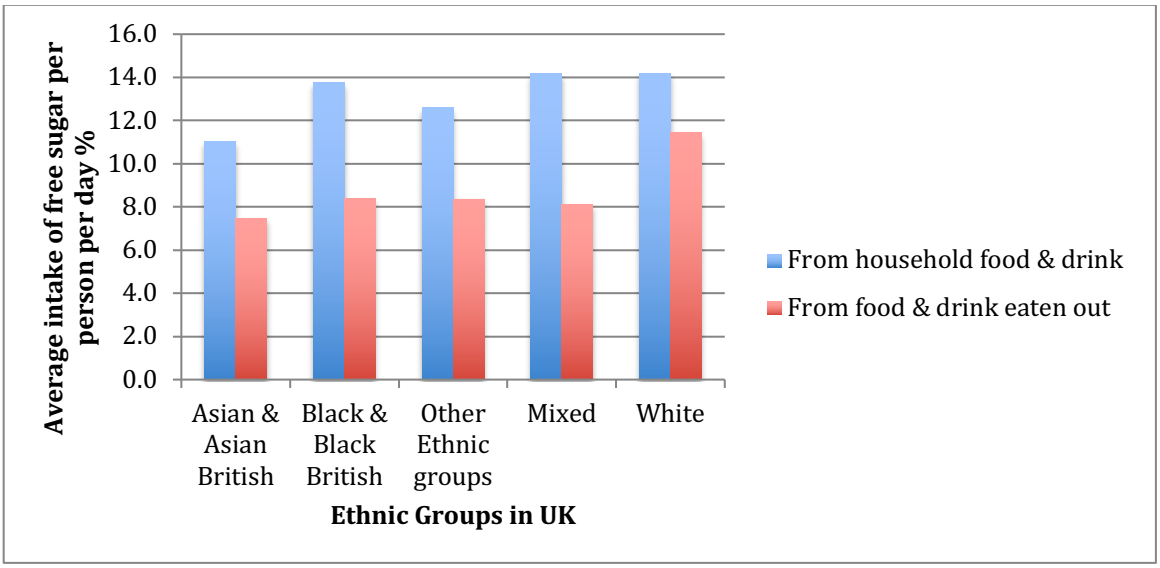

Fig. 14. The bar chart illustrates the 3-year average intake of free sugars among five major ethnic groups in the UK. Information gathered from Defra report (2014a; 2014b). The bar chart was made by Al Rawahi.

Many studies have reported on the factors that contribute to the intake of free sugars, including environmental and context, psychological, physical and social factors.

Examples of environmental and context factors include: sources of free sugars, prices, food content, availability, accessibility and the advertising of sugary foods, low household income; cultural commitments (Pawellek et al, 2017; Block et al, 2013; Feng et al, 2016; Terry-McElrath et al, 2012; Battram et al, 2016; Rehm et al, 2008; Emadian et al, 2017; Cortés et al, 2012; Thompson et al, 2009). Examples of psychological factors include the perception of sugary beverages; individual choice; knowledge level. Examples of physical factors are the intake of fast food and being passive e.g. watching TV for long period (Block et al, 2013; Feng et al, 2016; Battram et al, 2016; Rehm et al, 2008; Cortés et al, 2012; Thompson et al, 2009; Park et al, 2012). Finally, an example of social factor is parental control practices (Battram et al, 2016).

In addition, there have been several suggestions for interventions to reduce free sugars intake including deliver shocking educational messages (Block et al, 2013); reducing the availability of beverages (Terry-McElrath et al, 2012); educational strategies for both children and parents and develop a policy at both the government and school levels to reduce the intake of beverages (Battram et al, 2016).

A recent survey conducted in Europe sought to identity consumers' attitudes towards healthy eating (SENSUS, 2016). The participants included 2500 adults (males and females) ages 18 to 75 years old from five European counties, including the UK. The survey identified factors, such as monitoring sugary food intake, searching for foods with low free sugars, individuals' perceptions about artificial sweeteners, and their influence on the choice of buying, as factors related to free sugars intake (SENSUS, 2016). While this report highlighted some of the factors that need to be understood in order to encourage individuals to make healthy choices in relation to their free sugars intake, the published report did not include details about how the research was conducted, nor how the variables that influence free sugars intake were identified.

Much of the previous research in this area has not been informed by a theoretical framework of behaviour change which is essential in the design of effective behaviour change strategies Davis et al , 2014; Munro et al, 2007; Ogden, 2004; Forshaw, 2002). Interventions based on such models have been shown to be more effective than non-

theory based interventions (Abraham et al, 2009). Behaviour change theories and models, such as the Theory of Planned Behaviour and Social Cognitive Theory, have been developed to understand behaviours and achieve behavioural change (Ogden, 2012). In many cases, however, these theories and models of behavioural change have failed to facilitate change due to major limitations, such as a lack of focus on the circumstances of how a behaviour occurs or a lack of coherence (Michie, van Stralen, and West, 2011; Michie et al, 2014). In contrast, more recently a new model known as the Capability-Opportunity-Motivation-Behaviour (COM-B) model has been proposed. The COM-B model aims to understand or analyse behaviours and provide a "behavioural diagnosis" (Michie et al, 2014). According to the COM-B model, an individual's behaviour is the result of an interaction between three main conditions: the individual's *capability* to perform the behaviour, the *opportunity* that facilitates the behaviour, and the *motivation* that promotes the behaviour at a given moment Michie et al, 2014; Michie, and West, 2013; Michie, Atkins, and West, 2014).

The Theoretical Domains Framework (TDF) is a system that consists of 14 domains (constructs) that can be used along with the COM-B model for further analysis of behaviour (Atkins, and Michie,2015) . Both models can be used in conjunction to analyse factors that enhance or prevent the practice of any behaviour (Ogden, 2012). Both frameworks have been used in different fields related to health including: assessing barriers and enablers to delivery of the Healthy Kids Check (Alexander, Brijnath, and Mazza, 2014); assessing barriers of doctors toward appropriate prescription of older hospitalized patients (Cullinan et al, 2015); and development of resource linkage and an IT-enabled health coaching program for disadvantaged Latina moms with recent gestational diabetes (Handley et al, 2016). In these studies, the TDF framework and COM-B Model, have shown to be useful tools in diagnosing behaviour (e.g. identifying barriers and facilitators) and developing interventions that meet the need of individuals in the society.

To date, no studies have employed the COM-B model and/ or TDF to understand the barriers and facilitating factors to the reduction of the intake of free sugars to less than 5% of the total energy intake among White ethnic adults in the UK. In order to achieve this, a qualitative descriptive method was adopted that provides an in-depth identification of facilitating factors and barriers related to the reduction of free sugars

intake to less than 5% of the total energy intake among White ethnic adults in the UK. The finding from this study was informed to develop a questionnaire for an online cross-sectional survey.

Research Aim:

The aim of this research study is to understand the barriers and facilitating factors towards reducing the intake of free sugars to less than 5% of the total energy intake among White ethnic adults in the UK, using COM-B Model and TDF (Cane, O'Connor and Michie, 2012)

Research Question

What are the potential barriers and facilitators to behavioural change to reduce free sugars intake related to dental caries in a sample of UK adults who identify their ethnicity as White.?

7.2.METHOD

The purpose of this study is to understand the barriers and facilitating factors towards reducing the free sugars intake among White British adults in the UK. This means to have opinions and experiences of the white ethnic groups about the barriers and facilitating factors towards reducing the free sugars intake. The most suitable study design to achieve this aim is to employ a qualitative method for data collection and analysis in order to provide an in-depth understanding of facilitating factors and barriers related to the application of the new recommendation of free sugars intake less than 5% of the total energy intake among White adults in the UK. Use of qualitative method is appropriate for the purpose of the study as these methods facilitate exploration of the meaningful experiences and opinions of individuals about interventions (Ritchie, 2003; Lambert and Loiselle, 2008). The qualitative method has many designs which are used to explore (understand) or assess individuals' or groups' behaviours opinions and experience (Kitto, Chesters and Grbich, 2008). Such designs including: interview, observation, documentary and diaries analysis. The qualitative method produces rich and in-depth data about thoughts, beliefs and experience of individuals or groups (Sofaer, 1999). In addition, qualitative methods can explain some of the unpredicted results from quantitively methods through explore different reason for unexpected actions or behaviour (Morgan, 1998). Also,

qualitative data can the best data to develop of quantitative tools or interventions including surveys relevant to the groups or individuals, because, it represents their opinion and experience (Ritchie, 2003). However, the method required a lot of time , money and skills to recruit , apply and analyse the data; other qualitative designs might need longer time to conduct such as ethnographic data (Ritchie, 2003). Also, designs such as interviews need special skills and techniques to conduct them to avoid for example asking leading questions, doing coding and transcription (Ritchie, 2014).

7.2.1. Qualitative Approach

A qualitative approach means general philosophy aspect of conducting qualitative research (Williams, 2006); many different types of approaches have developed over years from different disciplines including social and health sciences (Creswell, 2013). The most popular approaches in the field of social and health sciences are grounded theory, narrative research, ethnography, case studies and phenomenology (Creswell, 2013; Creswell and Poth, 2018). Table 12 list the five approaches with their aims, research designs used for data collection, and outcome (Creswell, 2013).

Table 12: List the five qualitative approaches, their aims, data collection designs, and outcome adopted from Creswell (2013):

Approach	Aim	Data collection designs	End report
Grounded theory	Developing a theory grounded in data from participants in the field	Interviews	Generating a theory and illustrated in figure
Narrative research	Exploring the life of an individual through story telling of experience	Interviews Documents	Narrative description about stories of individuals' life
Ethnography	Describing and interpreting culture sharing patterns of groups	Interviews Observations Other sources	Description of a shared- culture within a group
Case studies	Develop in-depth	Multiple:	Detailed

	description and analysis of a case or multiple cases	interviews, observations, documents, artifacts	analysis of one or more cases
Phenomenology	Understand the essence of individual's experience in a phenomenon	Interviews Observations Documents	Description about individuals' experience

From the five approaches briefly described in table 12, the phenomenology is the appropriate approach for this study, because it focuses on understanding individuals' experience and opinions about a phenomenon within their context (Aspers, 2009; Creswell, 2013). This match with the purpose of this qualitative study which is to understand the barriers and facilitating factors towards reducing the free sugars intake among White British adults in the UK. Also, the phenomenology approach has an important feature which is called "bracketing" which means that the biases within the qualitative research should be acknowledged by the investigators and data, handling, collection and analysis could be affected by these biases (Laverty, 2003). Also, the "bracketing" feature encourage the investigators to try to minimize the biases as possible as they can; however, eliminating all biases is impossible (Lester, 1999). Therefore, the author tried his best to apply the "bracketing' feature in this study; but some biases assumed took place in the study which are discussed in the discussion section of this study.

7.2.2. Study Design

In this study, the qualitative data were collected through a series of semi-structured interviews (Yeo et al, 2014). With semi-structured interviews, interviewee can express their opinion and experience in their own words about the investigated topic (Yeo et al, 2014). In the case of this study would be barriers and facilitators to reducing free sugars intake. Interviewee's opinion and experience are guided through a series of questions which helps participants to think and provide answers within the frame of the investigated topic (Yeo et al, 2014). The interviewer can use probing questions to further the required information from the interviewee and the degree of

probing could vary between the interviewees depending on their response (Creswell, 2013). Other advantage of using semi-structured interviews within the selected sample frame (which is King's College London) is the flexibility in conducting the interview in accordance of suitability of the interviewer and the interviewee. The staff and students at King's have busy schedule which make it hard for the author to conduct a focus group to collect the data; also, the time was a factor to only consider semi-structured interviews.

7.2.3. Sample Population

Based on the literature, the sample of this study comprised White ethnic adults aged 18 and over. For the purposes of this study, the White ethnic adults invited to take part were those individuals who live in the UK, spoke English, and identified themselves as White; ethnicity is considered to be a form of self-identification (Leung and Stanner, 2011). Therefore, based on these criteria, the White ethnic adults would be: Scottish, English, Welsh, Northern Irish, British Irish, Gypsy or Travellerin (Office for National Statistics, 2015; P8.). Also, the samples should be free from systemic or local diseases (e.g., diabetes, as these conditions may affect decision making about free sugars intake and vary from the general population) and should be mentally sound. Any participant who don't fulfil the above criteria would be excluded.

7.2.4. Sample frame

After setting the criteria for the population sample, a sample frame, which is the source where the sample will be selected and recruited, was selected (Ritchie, Lewis, and El am, 2003). The sample frame for this study was based on the "flow population" method, which involves a process where samples are purposefully selected from a particular site or setting (Ritchie, Lewis, El am, 2003). In this study, the sample frame was the staff and students of King's College London, because this location was more practical than other sites in terms of accessibility. Also, students and staff are from different White ethnic background in the UK, possibly leading to a varied sample population. Also, a mix of students and staff will provide a wide range of opinions and experiences about barriers and facilitator to reduce free sugars intake.

7.2.5. Sampling Method

The nature of qualitative study is to explore (understand) or assess individuals' or groups' behaviours opinions and experience, therefore it does not need random sampling and generalisation, because of the diversity of individuals' opinion within the population (Marshall, 1996). Therefore, the samples are selected purposively and in small number (Ritchie et al, 2014). The purposive sampling is often used with in-depth interviews focusing on particular groups with particular features or criteria which could be age or race (Ritchie et al, 2014). For this study, purposive sampling was used because the aim of the study is associated with particular ethnicity which is White ethnic individuals and age from young adults and above; also, other criteria stated in the sample population section. Therefore, purposive sampling is the best method for this study. Within the purposive sampling, there are about 40 different strategies which help to generate the structure of the sample depending on the aim of the study and coverage (Patton, 2015). For purposive sampling in this study, maximum variation and snowballing strategies were used, as these methods allow sampling of participants or individuals based on the selection criteria but in a widely varied manner and accelerate the recruitment process (Ritchie, Lewis, Elam, 2003). Initially maximum variation strategy was used, however when the author felt that there was slowdown in the recruitment process and many interested individuals for the interview were not fulfil the criteria, he added snowballing strategies accelerate the recruitment process and to recruit relevant samples for the study.

7.2.6. Sample size

A large sample size is not essential for qualitative studies, as these types of studies are not dependent on prevalence for generalization (Ritchie, Lewis, and Elam, 2003). Furthermore, the information gathered in qualitative studies is quite rich and detailed, requiring time for analysis; also, there might be a repetition of the gathered information which is not cost effective (Guest, Bunce, and Johnson, 2006; Ritchie et al, 2014). Therefore, small sample sizes are typically used for qualitative studies; it is recommended to be with 12 and 60 samples (Creswell, 1998; Ritchie, Lewis, and Elam, 2003). However, sample size ultimately depends on the Saturation level; also, on other factors such as the availability of resources including budget, diversity of the samples and the practicality of acquiring the samples, and type of the study (Procter, Allan, and Lacey, 2010; Baker and Edwards, 2012). Based on the reasons above, the

sample size for this study, the authors planned to have a maximum of 30 participants, however when the saturation level is achieved, the recruitment is stopped. Other factors contributed to the suggested sample size for this study are time allocated for the current study and budget allocated for the incentives. In addition to the above reasons for the sample size, the findings of this study were used to develop the questionnaire for the online cross-sectional survey, therefore big sample size is not important at this stage. Unlike the samples diversity which is more important in this study.

7.2.7. Process for Recruitment

The process of recruitment for this study was via internet and email advertisements. This method of recruitment could reach potentially to larger participants at King's College London and the advertisements were accessible for 24 hours any time (Chin and Lee, 2008). However, the downside of using this methods recruitment is the missing of participants who are not accessing the advertisements and risk of having fake participants who don't fulfil the criteria and could lead to sampling biases (Chin and Lee, 2008). The researcher assumed that by using snowballing strategy would help to minimize the first downside. For the second downside, the researcher assumed through oral and email verification the participants could be checked if they meet the selection criteria for the study. Participants were recruited through King's College London based on the sample criteria. Initially, the researcher applied for advertisement for their study recruitment via Research Ethics Office at King's College London. Then, the office posted the advertisement of the study on the King's College London recruitment volunteer webpage for 1 month based on their policy. Also, they circulated the advertisement via King's College global to accolated the recruitment and made the advertisement more accessible to many students and staff at the college. The advertisement contained the following information: the purpose of the study, the criteria of potential participants, the incentives (to attract participants) and email address of the researcher (SHAR) for further information about the searcher. This method of recruitment allowed recruitment of volunteers without pressure and through informed choice.

Voluntarily interested participants who read the advisement on the webpage or email would send an email to the researcher for more information about the study. The researcher forwarded an information sheet to the interested participants; who agreed with the terms in the information sheet were kindly asked to select the time, date and setting at the convenience of the participants for the interview. In most of the cases the researcher was responsible to book the room for the interview where the participants felt convenience and have privacy. Participants who voluntarily agreed to take part in the study were asked to sign the consent form and fill out an application describing their demographic data at the time of the interview. The filling up of the consent form and the demographic data was completed through self-reporting. A reminder email was sent to the interested participants who did not book appointment to book an appointment for the interview. For those who booked appointment a reminder email was sent to them to remind them about the appointment date and time for the interview.

7.2.8. Interview Procedure and Data Collection

At the beginning of the interview a welcome introduction was provided to each interviewee. This included the follow steps: firstly, a brief description about the purpose of the interview session. Secondly the interviewees were given a hard copy of information sheet to remind them about the details of the study. Thirdly the interviewer reassured the interviewees that, all information which is collected and processed about them during the course of the research is be kept strictly confidential and done by the interviewer (SHAR). Also, the data is protected by our University procedures. Fourthly, the interviewer, restated that the interview would be tape recorded and transcribed by the interviewer (SHAR) after they consent the procedure. The tape recording was mention in the consent form and in the information sheet. In addition, the interviewer informed that the transcript will be coded with an anonymous code known only to the research team; any personal details will not be shared with any other researchers. Finally, after confirmation from the interviewees to proceed with interview, two detailed consent forms were given to them to sign and the interviewer would sign after the interviewee. A copy was given to the interviewee and the second was reminded with the interviewer.

After the introduction part, A topic guide was used to commence and hasten the interviews; the process of developing the topic guide is described below. The duration of each interview was set to a maximum of 60 minutes; however, there were variations among the interviews with times ranging from15 to 90 minutes. This is because some of the interviewees were telling detailed information and allocated time; others were providing important but short and not willing to answer more. During the interviews, any queries and questions were clarified. At the end of each interview, the interviewer acknowledged the interviewee for their time and a £20 amazon voucher was given to the interviewee as an appreciation. One interviewer conducted all of the interviews, using audiotaping to record the interview. The interviews were conducted at the Dental Institute, floor 18, Guy's Hospital Tower in London which was suitable for the interviewees. After each interview, the interviewer (SHAR) prepared transcripts verbatim, and a reviewer (JTN) was asked to review selected transcripts which was anonymised to the reviewer. After transcriptions, the interviews were analysed.

7.2.9. Development of the Topic guide

This semi-structured interview study used a topic guide to promote responses around the topic; the topic guide is useful in facilitating responses because of their pre-set questions (Arthur et al, 2014). The topic guide of this study was developed as a written document based on the reference of Arthur et al, (2014) and the questions were formulated as based on the BCW book guide (Michie, Atkins, and West, 2014) and mapped to the COM-B and TDF elements (Table 13). We took several steps to enhance the validity of the questions. First, the questions were developed by the interviewer (SHAR) based on the guidelines of BCW theory. Then, another investigator who his supervisor is, (NJT), independently reviewed the questions and made some modifications. After that, the interviewer practiced on conducting the interview with his supervisor and another individual who was a researcher at the college independently. The supervisor was satisfied about the performance e.g. rapport building and suggested slight suggestions. The researcher was satisfied about interview process, but he made slight suggestion at the end of the interview. He suggested to allow for any queries from the participant towards the end of the interview. The interviewer (SHAR) updated his supervisor about his performance and made improvements. After that the interviewer, conducted the first four interviews

and toward the end of the interviews he asked for feedback about the questions and the interview. All four were satisfied with the questions and felt comfortable answering the questions, however slight modifications were made based on the recommendation of the four interviewees. Finally, the interviewer (SHAR) made some changes in some of the questions based on his evaluation of the first few interviews.

Table 13: List of questions of the topic guide and their links with COM-B and TDF elements:

COM-B Elements	**TDF Elements**	**List of Questions**
Capability Psychological	Knowledge	• What do you understand by the term free sugars? • What kind of foods do you think are bad for teeth?
	Memory, attention, and decision processes	• Tell me about the kinds of things you would eat on a usual day. o Prompt for different meals ▪ Breakfast ▪ Lunch ▪ Dinner o Ask about snacks o Ask about drinks–any sugars or other sweetener (syrups, honey, etc.)
	Behavioural regulation	• How do you choose what to buy when shopping for food or meals? • Do you prioritize foods or menus with low sugars? o If yes, why? o If no, why not?

	Cognitive skills	• How easy do you find it to know how much sugars is in food or meals?
Opportunity Social	Social influences	• Is there anything in particular that influences what you buy in the way of food? • Prompt for: o Partner shops or shopping for partner o Shopping for children o Promotions in store o Illness (e.g., diabetes) o Hobbies etc. (e.g., sport) o Diet for slimming
Opportunity Environment	Environmental context and resources	
Motivation Reflective	Beliefs about capabilities	1) How easy do you find it to know how much sugars is in food or meals?
	Beliefs about consequences	2) What would be the best way to help you in selecting foods or meals to meet the recommended free sugars intake? a) Prompt for labels or colour coding foods that are high or low in sugars. What type of label: i) Amount (%) of sugars in food ii) Colour codes iii) Amount of exercise to burn off energy iv) Picture of tooth decay b) Education about the sugars in foods c) Government restriction on amount of sugars in food / food tax.
	Optimism	
	Intentions	
Motivation Automatic	Reinforcement	
	Emotion	

7.2.10. Ethical Approval

The study was approved by the King's College London Research Ethics Committee Reference: LRS15/16 2651. All participants provided written informed consent at the second stage of recruitment and before commencing interview activities.

7.2.11. Monetary rewards

An Amazon voucher valued at £20 was given to participants in appreciation of their time after the interview. The purpose of incentives is to encourage the participants to contribute to the study.

7.2.12. Data analysis

The data for this study were analysed thematically guided by the current theoretical categories/themes of the TDF and COM-B model (Braun and Clarke, 2006; 2013). In Qualitative analysis, it is commonly known that data collection and data analysis happen at the same time, because the preliminary analysis of the data helps to decide the areas which needs more details therefore relevant data is collected (Grbich, 2007; Silverman, 2006; Tesch, 1990). However, this might not be the case with studies which have predefined themes, in which the analysis of the data can occur after data collection. This is because the purpose of these study is to collect data to identify codes for the predefined themes (Grbich, 2007; Silverman, 2006; Tesch, 1990). In this study, the data collection and analysis started parallelly, but the collection of the data completed before data analysis. This is because, the author used predefined themes from COM-B model and TDF. The process of thematic analysis of the data was guided by the stages of thematic analysis suggested by Braun and Clarke, (2006) with slight modifications. This is because in this study the themes are already existed from COM-B Model and TDF , so the interviewer would not need to create themes; instead codes and subthemes were created.

The stages of analysing the data is described as following: **first**, the audio file for each interview was imported into the MAXQDA 12 (VERBI GmbH Berlin) qualitative analysis software which aided to analyse the data. MAXQDA 12 was used as opposed to Nvivo due to the simplicity in manipulation and the colourful nature, which makes the analysis more enjoyable. In addition, this software allows for control of the play speed of the audio files. Also, the interviewer, imported themes,

subthemes and codes into Excel sheet for the review process. **Second**, a theme guide was developed from the already published definition of the constructs related to the TDF domains (Cane, O'Connor and Michie, 2012); but with the addition of a term related to reducing free sugars intake. In other words, a general criterion related to reducing free sugars intake was considered before codes were collated under the themes of TDF. The theme guide helped the interviewer to find relevant codes for the study. Table 14 presents the definition of each TDF Theme in relation to reducing free sugars intake. This stage helped to assign all the themes with factors related to free sugars intake.

Third, after import of the audio files, each file was converted to a transcript for review by the interviewer (SHAR) to ensure consistency of the transcripts with the audio files. The length time to transcribe each audio recording varied between interviews depending the length of the interview session. It took the interviewer to transcribe one hour interview session, more than 10 hours, this is because the language and it is the first time for him to transcribe interview session. However, the hardship process of transcription made the interviewer to easily familiarize with the transcripts which is an important step in data analysis. The second investigator (JTN) then reviewed a subsample of transcripts and was in agreement with the interviewer. Also, at stage, the interviewer familiarized himself with the data through reading and rereading. **Fourth**, excerpts from the transcripts were coded, and relevant codes were collated under a single subtheme and each subtheme was defined. **Fifth**, each subtheme was mapped to a domain of the TDF. **Sixth**, the codes, subthemes, and themes were reviewed three times to ensure the validity of the content of each theme; this process helped to refine and improve the coding of the excerpts. The first investigator (SHAR) coded and allocate subthemes to TDF themes, the second investigator (JTN) who is his supervisor reviewed the coding and the subthemes and made some suggestions and the amendments were made. The Review process of the coding and allocation of subthemes again took place during the mapping and writing stages. Figure 15 illustrates the initial codes and subthemes in MAXQUDA and figure 16 illustrates the latest coding and subthemes in MAXQUDA.

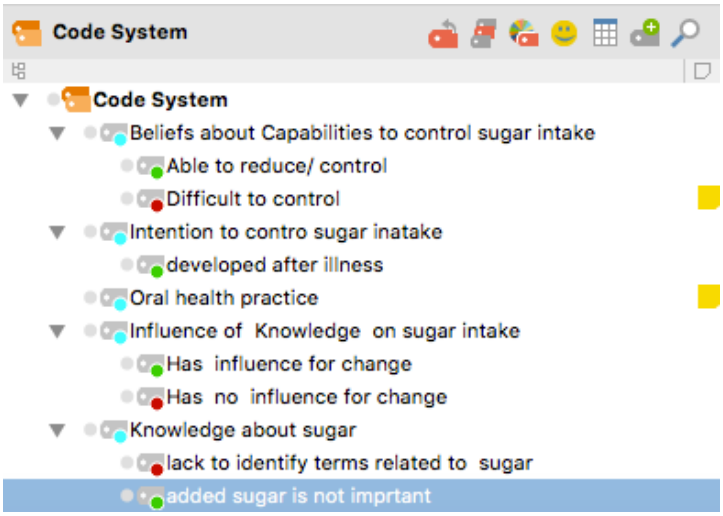

Fig.15. illustrates the initial codes and subthemes

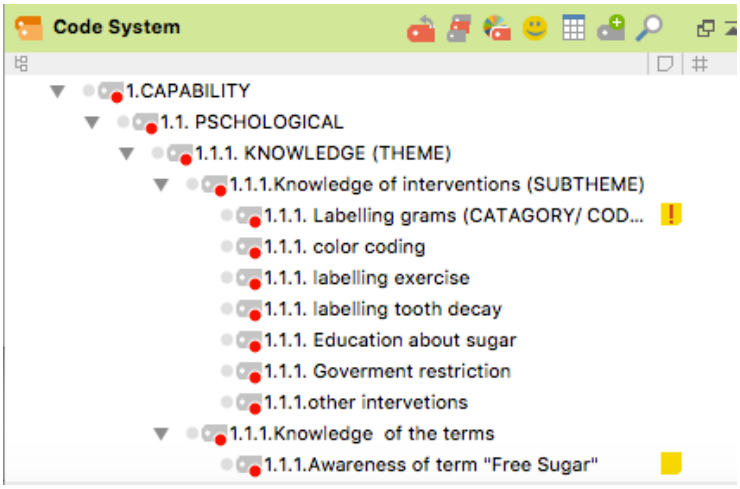

Fig. 16 illustrates the latest codes and subthemes

Table 14: Theme guide of definitions of the TDF themes related to reducing free sugars intake adapted from Cane, O'Connor and Michie, definition of TDF (2012):

TDF Domains Themes	Definition of TDF Themes
1.1.1.Knowledge	knowledge or awareness of the existence of information related to reducing free sugars intake
1.1.2Skills	A psychological ability or proficiency acquired through practice issues related to free sugars intake.

1.1.3.Memory, Attention and Decision Processes	The ability to retain information related to reduce free sugars intake, focus selectively on aspects of the environment and choose between two or more alternatives
1.1.4.Behavioural Regulation	Anything aimed at managing or changing objectively observed or measured actions related to reduce free sugars intake
1.2.1.Skills	An ability or proficiency acquired through practice issues related to reduce free sugars intake
2.1.1.Social influence	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours related to reduce free sugars intake
2.2.1. Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour related to reduce free sugars intake
3.1.1.Social and professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting related to reduce free sugars intake
3.1.2.Beliefs about Capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use towards free sugars intake
3.1.3.Optimism	The confidence that things will happen for the best or that desired goals will be attained related to reduce free sugars intake
3.1.4.Beliefs about Consequence	Acceptance of the truth, reality, or validity about outcomes of a behaviour related to reduce free sugars intake in a given situation
3.1.5.Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way related to reduce free sugars intake.
3.1.6.Goals	(Mental representations of outcomes or end states that an individual wants to achieve related to reduce free sugars intake.

3.2.1.Social and professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting related to reduce free sugars intake.
3.2.2.Optimism	The confidence that things will happen for the best or that desired goals will be attained related to reduce free sugars intake
3.2.3.Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus related to reduce free sugars intake.
3.2.4.Emotions	A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event related to reduce free sugars intake.

7.3.RESULTS

The qualitative semi-structured interviews identified many facilitating factors and barriers to behavioural change in order to reduce the intake of free sugars to less than 5% of the total energy consumed among White ethnic adults in the UK. The findings of the study are described below with respect to characteristics of participants, barriers and facilitating factors in accordance to COM-B model and TDF.

7.3.1. Characteristics of Participants

Data saturation occurred at 27 participants. Most were from English, British, Irish, Scottish and other White ethnic groups. These different categories of White ethnicity are based on ethnicity classifications of Office for National Statistics, UK (Office for National Statistics, 2016). A similar number of males and females and of staff and students were included. Table 15 presents the detailed characteristics of the participants.

Table 15: Characteristics of participants of qualitative interviewing:

Characteristics		Frequency
Gender	Female	16
	Male	11
Job title	Staff	14
	Student	13
White Ethnicity	Scottish	1
	English	10
	British	7
	Irish	1
	Others	8
Age	Ranged from 19 to 59 years old	

7.3.2. Barriers and Facilitating Factors

The study employed the TDF and COM-B model to identify factors that underlie the behavioural change to reduce free sugars intake to less than 5% of the total energy to among White British adults. The TDF domains were used as themes to analyze the facilitating factors and barriers and then were mapped to COM-B model elements. The TDF domains captured various factors that may influence the change in behaviour to consume free sugars of less than 5% of the total energy intake. The factors that were reported to influence the free sugars intake fitted well within the framework of the TDF themes. No comments could be coded to the TDF Optimism theme, which is associated with the Automatic and Reflection elements of COM-B. The following sections describe some of the facilitators and barriers identified in each theme.

7.3.2.1.Psychological Capabilities

7.3.2.1.1. Knowledge

In the context of this study, knowledge can be seen as both a facilitator and a barrier to change in terms of reducing free sugars intake behaviour. For example, awareness of healthy and unhealthy foods, including drinks and acidic foods, which can cause caries as well as awareness of the amount of free sugars in food and the time to eat sweets can help to increase the possibility of reducing free sugars intake**.** Quotes number one and two present examples of relevant quotation for knowledge as facilitator.

1)"bad for your teeth aim biscuits sweets I think from what I was told is more about when you eat than what you eat, so if you eating between meal and the stuff is on your teeth all you day that's worse but also acidic food and sugar specifically."" (Participant-WT24)

2)" I think carbonate drinks are bad for your teeth. that what I can think of my top of my head "(Participant-WT25)

However, knowledge can be act as barrier to reduce free sugars intake. For example, lack of knowledge about the term free sugars and sugars and lack of understanding of the recommended free sugars intake per day. Quotes number three and four present examples of relevant quotation for knowledge as barriers.

3)"I have no knowledge of what the term free sugar means. " Yeah I don't have any educational about sugar" (participant-WT3)

4)"Like if it says 10% of sugar than I don't know how much sugar is

low and much sugar is high than I don't know what that 10 % is mean." (Participant-WT1).

In addition, the level of knowledge about the interventions to reduce free sugars consumption can also influence the consumption of free sugars by individuals. For example, awareness of a colour-coded label system can help to identify the amount of free sugars in a particular food. Quotes number five presents examples of relevant quotation for knowledge about intervention as facilitator.

5) "But I think those traffic lights are very useful to see how much sugar or salt or fat or how much you're in taking."(Participant-WT7).

A lack of knowledge about these interventions, however, can act as a barrier. Specifically, a lack of awareness of food labelling and colour-coding systems can result in misunderstanding or confusion in interpreting the free sugars content of a food. Quotes number six and seven present examples of relevant quotation for knowledge about intervention as barrier. Table 16 presents the remaining subthemes related to knowledge and examples of quotes.

6)"From what I have read it, it's a complicated thing you know how they put it and then the difference in different kind of sugars, the truth is even having read about it I don't' understand that much about so I would rarely look at the labels." (Participant-WT24).

7) " Like if it says 10% of sugar than I don't know how much sugar is low and much sugar is high than I don't know what that 10 % is mean. I need to know okay below 10% is good and above 10% is bad something like that. If I know that then I can judge what that number means. but if you just give me a number and I don't know what does mean, then I can't use that in my decision."(Participant-WT1).

Table 16: Subthemes and their quotations related to knowledge:

Theme	Subtheme	Related Quotation
Knowledge	Knowledge of healthy foods for teeth	"IT: What food do you consider are healthy for your teeth? WT2: Healthy vegetables fish" (Participant-WT2)

	Knowledge of acidic food	"...also, acidic food and sugar specifically." (Participant-WT24)
	Knowledge of the amount of free sugars in food	" Yeah I know I have no idea how much sugar is in fruits I couldn't even has it a guess I know there is natural sugar in fruits, but I don't how much of these is bad for you or not."(Participant-WT14) "my food that I prepare myself because I don't consider to be higher in sugar. " (Participant-WT25)
	Knowledge of the time for sugary food	"so I think, fruits with high sugar content, as in sweets with high in sugar content also I think carbonate drinks are bad for your teeth. That's what I can think of my top of my head . that what things I associated with and I am careful when I am consuming and I consider them bad for my teeth." (Participant-WT25)
	Knowledge of the term Free Sugars	"free sugar I wouldn't know uummmm [laughing] I don't know free flowing sugar like from a bag, I am not sure to be honest I have never heard that term before. " (Participant-W10)
	Knowledge of the term Added Sugars	awareness of the term Added sugars was limited to 7 out of 27"
	Knowledge of recommended daily intake	"my food that I prepare myself because I don't consider to be higher in sugar. " (Participant-WT25)
	Knowledge of colour coding system	" thinking about now I don't actually know what green means I just know that means good but I don't know what the cut off is for each one." (Participants-WT14)
	Knowledge about food calories	"umm umm I would say I usually go for , its healthy, there is usually one under 500 calories and one is over, so on the days that they have one under 500 calories I really like the look of it I will have that because it's the healthy option again if there is something I don't like either of the options I will go for jack of potato, just because again I don't really like it, but it's healthy and I don't like the other two things okay they have." (Participant-WT14)
	Need for knowledge on effect of free sugars on the body	"I think you know if you show some fact like actual facts that goes to body you know like body like VC you know if you compare the fats and muscles and grams because I see stuff like in the internet as well may be that could help I don't know " (participant WT20).
	Need for knowledge on effect of free sugars on the teeth	" umm I would say there could be more of information about natural sugar and dangerous they could pose to someone's teeth and the health of their teeth" (participant WT23) "I think you know if you show some fact like actual facts that goes to body you know like body like VC you know if you compare the fats and muscles and grams because I see stuff like in the internet as well may be that could help I don't know " (participant WT20).

	Need for knowledge on the recommended daily free sugars intake.	" I would like to have information that's in context and gives me a better idea of the levels of sugar that not merely in individual foods but that is reasonable so if you are talking about under 5% what does it mean on ordinary diet what would that actually mean in terms okay mean someone like me I don't know sugar in my tea and coffee so the sugar that I see going into my food is if my wife makes a cake I know that she puts that amount of sugar into the cake, then I have a piece of cake so its percentage of that sugar, but a part from that I don't really know what's, do you understand what I am saying, so telling me a percentage that I need or shouldn't exceed is one thing but actually what's really means in terms of day to day of normal food that's I would like to be educated on better so I can make better choices based on that." (participant WT17) " I need to know okay below 10% is good and above 10% is bad something like that. If I know that then I can judge what that number means. but if you just give me a number and I don't know what does mean, then I can't use that in my decision."(participant WT1).
	Need for knowledge on colouring coding system.	" I do like to read labels I do like to understand how this is it's a red label and its say 45 % 45% of what ? and then its say its daily intake" (Participants-WT20)
	Need for knowledge on hidden free sugarss.	"think it's very important to educate people on the hidden content of foods if you know what I mean " (participant WT7)
	Need to understand the application of the recommended daily free sugars intake in everyday life	"I would like to have information that's in context and gives me a better idea of the levels of sugar that not merely in individual foods but that is reasonable so if you are talking about under 5% what does it mean on ordinary diet what would that actually mean in terms okay mean someone like me I don't know sugar in my tea and coffee so the sugar that I see going into my food is if my wife makes a cake I know that she puts that amount of sugar into the cake, then I have a piece of cake so its percentage of that sugar, but a part from that I don't really know what's, do you understand what I am saying, so telling me a percentage that I need or shouldn't exceed is one thing but actually what's really means in terms of day to day of normal food that's I would like to be educated on better so I can make better choices based on that." (participant WT17)
	Need for knowledge on healthy eating	" yes, I think would umm I think especially for me realise the different between or perhaps need information about the difference between the different types of sugars umm but then you get all education knowledge about what you are eating and how it all what's there I think is all in the sugar it is useful." (Participants-WT26)
	Need for knowledge on different types of free sugars.	
	Need for knowledge on free sugars content of processed foods and ready meals.	" I think it's important that people know exactly what is good and what is bad especially when it's come to the processed food and ready meals because people think that for example a ready meal Bolognese wouldn't have any added sugars on it because it's something you would not think it's sugary when it has a lot of sugar in it make the flavour's right for example." (participant WT7)
	Need for knowledge on effect of exercise on free sugars intake.	"I am not so sure that would help half an hour of what ? half an hour of high intensity exercise or just half an hour of exercise in general I think that would wind up in a way I am suspect may be more information than you could easy on a label or product without you know minimizing it to a point it doesn't mean anything anymore. "(participant WT17)

7.3.2.1.2. Psychological skills

The psychological skills identified in this study included the ability to calculate the amount of free sugars consumed per day, interpreting the labelling of foods, and assessing the free sugars content of foods or meals act as facilitator. Quotes number eight and nine present examples of relevant quotation for psychological skills as facilitator.

8)"Well I know that for example the cereal that I have is 14% I think of my allowance for calories intake I know that banana is , I don't know what banana is , but I know the salad is very low percentage so the turkey that I put in my salad is about 25% the salad is about 10% so with my two meals and my snack, my breakfast my snack and my lunch I now about 50% so that leave me 50% for my evening meal or anything else so that how I kind rationale things." (Participant-WT23)

9) "yes a lot of food I buy that healthy food tend to show the amount of the correct kind of sugar kind of in them, they will say let us assume so on the package they will say per 100 grams you know percentages and amount of sugar so I know if it has 30 grams of normal sugar and then 90 grams total of carbs per day and then best have what else say 20 grams saturated-fat 70 grams of normal fat in a day so I look in the package and normally have the values so you know calories carbohydrate of which sugars fats and salt....." (Participants-WT27)

However, some of the participants stated that they do not perform free sugars assessment when they eat meals. This can act as a barrier towards reducing free sugars intake. Quotes number 10 presents an example of relevant quotation for psychological skills as barrier. Table 17 presents the remaining subthemes related to psychological skills and examples of quotes.

10) " aa so don't do it in meals I don't look at all really, in may be snacks I will look for calories and I will think of how many calories in in foods and line meals and kind of snacks things , but I wouldn't often look how many grams of sugar."(Participant-W13)

Table 17: Subthemes and their quotations related to psychological skills:

Psychological Skills	Ability to assess free sugars content in foods and meals	"so the most commonly used one is the circle with different segments in it you know the one I mean and I think some understanding of sugar how much sugar is in something compared to the recommended limits so you can see how much this is given you toward overall recommended limit, which help inform you know am I going to use all of me sugar allowance on this one thing because I really wanted whereas you know if I have this other things it's only got half the amount so that leave another half for something else later on the day. "(Participant-WT19)

7.3.2.1.3.Memory, Attention, and Decision Processes

Memory, attention, and decision processes include remembering free sugars intake advice and the amount of free sugars in foods or meals and choosing food with lower free sugars or natural sugar increases the possibility of reducing free sugars intake. Quotes number 11 to 13 present examples of relevant quotation for Memory, attention, and decision processes as facilitator.

11)"There is a brand very good but very naughty very bad for your chocolate called Vego its delicious it is 900 calories"(Participant-WT15).

12)"Drink every single drink I think is bad for you a lot of sugar, compare with water except for water and you know that's it. and also you feel hard done by because the water is cheaper than the soft drink or the fruit juices " (participant-WT27)

13)"if I had the choice between like dried fruit that has that uses sugar as well that says that I don't know apricot sugar and somethings I wouldn't buy that, I would always buy the natural things" (participant-WT9)

In contrast, memory, attention, and decision processes can also act as barriers towards change. For example, some participants indicated that they do not pay attention to or are less focused on free sugars intake and identifying free sugars content in foods. Instead, attention is paid to food that has been reduced in price or is part of a special offer. Also, some of these participants indicated that when they eat sweet food they

think of their body weight rather than their teeth and other participants indicated that they prioritise taste over health. Moreover, some of the participants prioritize frequency of eating free sugars over the amount of free sugars and other participants choose food with low calories instead of food low free sugars. In addition, some of the participants raised concerns about their trust of the labelling system and stating that these concerns influence their decision process to reduce free sugars intake. Quotes number 14 to 22 present examples of relevant quotation for Memory, attention, and decision processes as barrier.

14)" I never think about the sugar intake." (Participant-WT3).

15)“ IT: alright, How easy do you find it to identify how much sugar is in your food or meals? WT18: I don’t pay attention to be honest to you I mean as far as I guess Intuitively I try to get every now may be this is foolish Intuitively I try and gauge whether you know if I am eating a farm loaded sugar can you know that clearly the ideal."(Participant-WT18).

16) " So, I don’t think if I eat chocolate bar I think more about weight gain than my teeth definitely." (Participant-WT13).

17)"I love bargain I love bargain and if something on sale I would be more like to pay attention." (Participant-WT15)

18)" I don’t always necessary look at the kind of nutrient value I guess of a product if its half price." (Participant-WT23)

19) “I would not compromise for the taste. so, if I went for the low fat and low sugar option and it didn’t taste good, I wouldn’t buy it again. “ (Participant-WT4).

20)“I don’t really trust most of packaging and labelling things a lot of it not really informative to the lay person.” (Participant-WT4)

21) " I think from what I was told is more about when you eat than what you eat, so if you eating between meal and the stuff is on your teeth all you day that's worse ." (Participant-WT24)

22)" I would say I usually go for , its healthy, there is usually one under 500 calories and one is over, so on the days that they have one under 500 calories I really like the look of it I will have that because it’s the healthy option again if there is something I don’t like either of the options I will go for jack of potato, just because again I don’t

really like it, but its healthy and I don't like the other two things okay they have." (Participant-WT14)

Also, interventions can act as facilitators in memory, attention, and decisional processing in relation to free sugars intake. For example, a free sugars content colour-coding system can facilitate quick comparisons and selections between two products. Furthermore, such a system can attract attention when selecting food and can indicate healthy and unhealthy food choices. Quotes number 23 to 26 present examples of relevant quotations for Memory, attention, and decision processes related to interventions as facilitator.

23)" A traffic light system so like the green the orange and red I think they are useful just at glance specially when campaign two products.... just at a glance I think when you are in rash it might not be the most accurate means but again if you are comparing two products I think it's very quick way of choice yeah."(Participant-WT11)

24)"Well I mean you know naturally looking something red it says you know around everywhere it says stop or warning or alert or something so if you see something is green on it I will draw your eyes first to second attention you will look at it and say oh its healthy its fine and it has some red on it you will know kind of you can compare things better if I am looking at two sets of numbers let say I don't know chicken breast vs chicken thighs for example or different types of mincemeats if I am sticking at two set of numbers it's hard to compare them among each other but if say one had all green and one had three green and two yellow then you could quite easily see that the green one is better and in one part so I think it's very useful" (participants-WT27)

25) "yeah I mean when I am looking for example a sandwich in the supermarket and it has how much salts fats sugar is in it and then I there is it has the grams how many grams or percentage and then the green or yellow or red you can just glance at it and think oh yeah that's not that sandwich is less healthy and that sandwich next to it." (participant-WT25)

26) "they have its both on the traffic light thing so it has the little label

it has the colour in which attract your eye." (Participant-WT7)

Alternatively, interventions can also have minimal influence on memory, attention, and decisional processing in relation to reduce free sugars intake, as some participant indicated that they do not pay attention to the colour-coding system. Quotes number 27 to 29 present examples of relevant quotations for Memory, attention, and decision processes related to interventions as barrier. Table 18 presents the remaining subthemes related to memory, attention, and decision processes and examples of quotes.

27) "To be honest it would need to be quite well kind of publicized and advertised otherwise I would not think of colours."(Participant-WT10).

28) "hey have got different like red yellow and green, the more green I get the better but I tend to focus on like the calories and fat saturated fats because I know that it's bad for you as well. " (Participant-WT14)

29) " yeah they do have the colour coding in they but I never look at the sugar . all there is like four or five things on there isn't that and I near look at the calories and never look the salt or sugar or ." (Participant-WT13)

Table 18 Subthemes and their quotations related to memory, attention, and decision processes:

Memory, Attention and Decision Processes	Choose food with lower free sugars	"Drink every single drink I think is bad for you a lot of sugar, compare with water except for water and you know that's it. and also, you feel hard done by because the water is cheaper than the soft drink or the fruit juices " (participant-WT27) "if I had the choice between like dried fruit that has that uses sugar as well that says that I don't know apricot sugar and somethings I wouldn't buy that, I would always buy the natural things" (participant-WT9)
	Remember /Retain advice on free sugars intake	" a friend who is a dentist and she told me not to put sugar anymore, so about 5 years I got stopped putting sugar."(Participant-WT5).
	Remember/Retain information of free sugars content in foods	" there is a brand very good but very naughty very bad for your chocolate umm called Vega its delicious it is 900 calories"(Participant-WT15).

	Main attention is on food calorie	"yeah, I think I mainly look at calories and then if it's got one of those umm you know there some package have some five little boxes where has like fat sugar and salt and something else " (Participant-WT14)
	Prioritize food taste over health	"Although I know the risks of consuming a lot sugar still I do , despite that because I prioritizing taste as suppose over the health risk"(Participant-WT11) "I would not compromise for the taste. so, if I went for the low fat and low sugar option and it didn't taste good, I wouldn't buy it again. "(Participant-WT4).
	Prioritize free sugars intake when buying food over buying meals	"I wouldn't be I mean I just assume as not as much sugar and its less important to me if the sugar in like curry but more impotent if I am having like a snack."(Participant-WT16)
	No Attention on free sugars content	" IT: alright, how easy do you find it to identify how much sugar is in your food or meals? WT18: I don't pay attention to be honest to you I mean as far as umm I guess Intuitively I try to get every now may be this is foolish Intuitively I try and gauge whether you know if I am eating a farm loaded sugar can you know that clearly the ideal."(Participant-WT18).
	No attention on Nutritional Values	"but I wouldn't often look how many grams of sugar." (Participant-WT13) " I don't always necessary look at the kind of nutrient value I guess of a product umm if it's half price." (Participant-WT23)
	Tooth decay image helps in paying attention	"I think tooth decay image would be the best because if someone can see it then they you know attract the eyes a bit more as opposed to number or colours I don't think. ".(Participants-WT22)
	Pay attention to calories and fat saturated fats	"I tend to focus on like the calories and fat saturated fats because I know that it's bad for you" (Participant-WT14)
	No attention on colour coding	"To be honest it would need to be quite well kind of publicised and advertised otherwise I would not think of colours."(participant-WT10).

7.3.2.1.4. Behavioural Regulation

Behavioural regulation factors play an important role in minimizing free sugars intake. Setting of an action plan for daily free sugars intake, selecting small size portions of sweets, and prioritising fresh food can help in reducing free sugars intake. Quotes number 30 and 31 present examples of relevant quotation for Behavioural regulation as facilitator.

30) "So I plan the entire day around this so as I said I wake as I said I need some sugar today I am going to have may be yogurt with some fruits in the morning and have a porridge may be slightly later and then have big lunch then after lunch have couple of coffee with milk and then you know I am like energized and full of energy when I get there because I have sugar still in there and my lunch still working for me so when I go to the gym a I burning off complete like in zero and I tend not to eat for about half an hour after I leave the gym because when I get home I get my dinner so I have the meat with vegetables, and that just." (Participant-WT20)

31)"Yeah, I would, if I was to buy the big bars do you know like one pound for Cadburys big bar I will just eat it all, so just buy the 60 pens little small bars and I would have a bar of that." (Participant-WT7)

Some participants said that they think first their body weight and fitness then dental health. Also, considering food calories first then other element of food labelling can act as a barrier, because not all low-calorie food has low free sugars. Quotes number 32 and 33 present examples of relevant quotation for Behavioural regulation about as barrier. Table 19 presents the remaining subthemes related to behavioural regulation and examples of quotes.

32)"I think I would first think about kind of put my fitness and weight before I think about teeth." (Participant-WT1).

33)"yeah, I think I mainly look at calories and then if it's got one of those you know there some package have some five little boxes where has like fat sugar and salt and something else and they have got different like red yellow and green, the more green I get the better " (Participant-WT14)

Table 19: Subthemes and their quotations related to behavioural regulation:

Behavioural Regulation	Prioritise fresh foods then carbs	" when I cook when I buying food obviously my priority fruits and vegan and then carbs " (Participant-WT12).

	Need for self-monitoring system	" I don't think so other than like I say I would find it genuinely useful to have some kind of way monitoring my own sugar intake that was Doable without you know I am not sure I really know how much sugar in my diet." (Participant-WT17)

7.3.2.2. Physical Capabilities

7.3.2.2.1. Physical Skills

Such skills include the selection of cheap and healthy foods, selection of small portions of sweets, cooking/ preparing healthy food, not adding free sugars to foods or drinks, and the ability to determine the free sugars content on food labels. Quotes number 34 to 36 present examples of relevant quotation for physical skills as facilitator.

34)" She wants me to help her because I am quite efficient because I find real cheap and healthy food and get them but she is quite bad for it."(Participant-WT27)

35) "Drinks teas and coffees are the things I drinks the most of, I drink them at work during the day, I don't add any sugar on" (Participant-WT15)

36)"if I look in the labels that I can find some kind of sugar content" (Participant-WT18)

However, some of the participants stated that they add free sugars in food. Quotes number 37 present examples of relevant quotation for Physical Skills about intervention as barrier. Table 20 presents the remaining subthemes related to physical skills and examples of quotes.

37)" I do put sugar in it, for some strange reason I can only I like tea but it has to have some sugar in it, like half spoon still I want to have sugar in there because of the flavor of tea on its own I don't really like unless it's a bit sweet where its coffee it's a bit different. (Participant-W7)

Table 20: Subthemes and their quotations related to physical skills:

Physical Skills	prepare healthy food for cooking	"when I cook I tend to cook something Japanese so we would have either kancho or we could have miso soup with some rice and vegetables we would have Japanese curry which is slightly heavier we would have for lunches umm so this is one big hobby influence me." (Participant-WT20).
	Need for cooking skills	"also show them how to cook and not to rely on paying from the shops."(Participant-WT2)

7.3.2.3. Social Opportunities

7.3.2.3.1. Social influence

Parents and friends offer both positive support for the reduction of free sugars consumption and a possible negative influence. The participants indicated that parents, for example, can limit the purchase of sweets or sugary foods. Also, trusted members of the family or society can encourage individuals to consume less free sugars. One participant stated that modelling from other culture can help the participant to reduce free sugars intake. Quotes number 38 and 39 present examples of relevant quotation for social opportunities about as facilitator.

38)*"My mum does sort of put a limits, on she like you can't buy too much of like you know sweets or you know you've got make sure you try to keep it quite balanced so you know you must have this amount of fruits this amount of she there is more concern that like the main meal is like what I am focusing on the bigger part and what I am buying as opposed to like any sweets or. Yeah."(Participant-WT22).*

39) "My interest in Japanese street fashion does affect my choices when buying food because I try to eat healthy so I can hopefully fit the small sizes better "(Participants-WT1)

In contrast, family members and friends may encourage the purchase of sweets or unhealthy food. Also, individuals can be influenced by a friend's unhealthy lifestyle . Quotes number 40 and 41 present examples of relevant quotation for social opportunities about as facilitator.

40) "My other daughter like biscuits like ready made biscuits of like

digestive she like that those I will be them for her umm, yes the list is made by the girls and dad goes.... as I said before that my eating habit tend to be shared so when the biscuits get opened I am in there too [laughing] " (Participant-WT17).

41)"Occasionally we go out for dinner with my friends and my partners that less healthy so might have a burger with chips." (Participant-WT3).

From the point view of interventions, use of picture of tooth decay for sweet foods positively predicts a decrease in free sugars consumption. Parents may not like their children to bring home sweets with the ugly picture, so this picture may influence the parents to help their children avoid sweets. For an individual, such picture of tooth decay may encourage him to avoid sweets. Quotes number 42 present an example of relevant quotes. Table 21 presents the remaining subthemes related to social influence and examples of quotes.

42) " yeah probably I don't know I just can't see it happening just because like kids like package of skittles whatever I don't think the parents which really like it if their kids come home with package of skittles with wiki teeth on them, it will put me off. "(Paerticipant-WT14)

Table 21: Subthemes and their quotations related to social Influence:

Social influence	Parents encourage free sugars intake with exercise	" IT: you told me that you parents also told you that is fine if you are young to have sweets. WT16: yeah well in a way I mean if you going to burn it off then it's okay."(Participants-WT16). "umm not really, I tend to just eat lots of fruits which obviously sugar but it's easy and you know when I was ill when I was younger my mum would always give a lot citric fruits because it has a lot of vitamin c that help dealing with flu."(Participants-WT20) "I think in my idea and how I was brought up sandwiches in the morning are not supposed to be too sweet. " (Participants-WT20) " that I was what brought up eating it's quite easy to cook you can make a lot on Sunday and last for the rest of the week you stick in the microwave [laughing] ." (Participants-WT19)
	Parents' beliefs are a strong influence on my beliefs about free sugars intake	
	Partner Influences on eating	"yeah , probably if she comes with me she might say let's try this or try that ..... yeah , I am quite flexible , I think." (Participant-WT16).

	Health professionals influence on eating	"yeah I suppose I might be effected by people whose judges I trust for example if my brother came to my he is a doctor and said to me , for example I buy we have long stand we talk about things occasionally food related , and he is of the opinion you should not have margarine you should have a butter because he think that margarine is so processed is much worse for you than any other stuff that's native aspect of butter. So, for example I have charted with him about that and now I buy butter rather than margarine, so he affects me and if he was to say to me don't buy the Lloyd Grossman pasta sauce because it's so processed it's got so much sugar you know it's really any it's going be bad for you in long run, then I would listen to him. " (Participant-WT-18)
	Friends' experience of ill health influence on eating	"like I have friends how won't drink fizzy drinks and stuff because she's had so many fillings but I have had one filling about 6 years ago , so I don't think if I eat chocolate bar I think more about weight gain than my teeth definitely."(Participant-WT13).

7.3.2.4. Physical Opportunities

7.3.2.4.1. Environmental context and resources

The environmental context and resources have a major influence on the consumption of free sugars. The cost of food may promote the consumption of cheap high free sugars content foods. Also, the participants stated that social media can promote healthy food choices.

43)" For example they have a lot of vegetable which one I think it's a 60 p value and then like right at the front of the store as soon as you go in my store anyway so that influence me to choose that vegetables." (Participant-WT7).

44)"Yeah and fruits is free at university so we can take it." (Participant-WT16).

Participants raised many concerns about the fact that environmental context and resources can increases the consumption of free sugars. Many perceived there to be limited access to healthy food outside the home particularly snack foods. Also, participants voiced concern that healthy foods are expensive, and many low-income families have limited money for food. Advertisements and promotions can also contribute to an increase in free sugars consumption.

45)"I think if I wasn't too worry about the money at that time I would go for a healthier option.""(Participant-WT1)

46)"Yeah so sometime when I am sick now when I am adult I buy the Lucozade."(Participant-WT25).

47)"Now money is more of a factor I have moved I don't have easy access"(Participant-WT18).

Part of the environment context and resources are interventions, which can serve as facilitators or barriers to the reduction of free sugars intake. For example, labelling food packaging with proper free sugars content and colour-coded labels on food products can help in the selection of foods with low free sugars. Also, education about free sugars via television can increase awareness of healthy foods and unhealthy foods. Table 22 presents the remaining subthemes related to environmental context and resources and examples of quotes.

48) "Yeah, I think I mainly look at calories and then if it's got one of those umm you know there some package have some five little boxes where has like fat sugar and salt and something else " (Participant-WT14)

49) " They have got different like red yellow and green, " (Participant-WT14)

50) " I would say when I heard about Jamie Oliver doing his TED talks with ABC in his TED talks for with big wheel barrel of sugar and the tips on the stage what I saw a tiny snip of that I what it to say the whole speech" (Participants-WT15)

Table 22: Subthemes and their quotations related to environmental context and resources:

Environmental context and resources	Restaurants foods are expensive	" umm well for lunch especially I have home made because of price first of all can't afford to go to Pret every day to get a to get a sandwich and then I choose it also on what something what's going to be filling because I get hungry a quite a lot and then taste as well am and also health but I consider health in all my meals not just I am making that food to be healthy if I wasn't make that food than I would still choose a healthy options if I have enough money to go." (Participant-WT7).

	Social media is a source of information for foods and health	" aumm probably little a bit I have actually seen some of advertise they are not advertisement but you know like you say in the Facebook like a little thing you can click on it and you can see what you want to buy, I click on one of them and told me a bar of chocolate is this many setups or a bar or bowl of pasta is this long in the gym , do you know that kind of thing from actually seeing that" (participant WT7)
	Drink more fruit juice when ill	" umm so if I ever get if start get cold or feel a bit ill I will always drink a lot of apple juice or eat some oranges juice or take some vitamins or something like that, because I think it might help but I might be too late and then I have to get." (Participant-WT13).
	Eat more Sweet when ill	"Yes, I have actually I have just been sick and If I have to go shopping when I am sick umm it's harder for me to kind of resist the unhealthy food. Like normally I have some well power like now I shouldn't do that that's not good for me [smiling], but when I am sick that doesn't work I just go for whatever easy and tasty because usually if I am sick I don't really feel like eating so I need to make something very appetising for me to make sure I still eat enough , so I eat less healthy when I am sick [laughing] usually." (Participant-WT1).
	Limited access to healthy food.	" Now money is more of a factor I have moved I don't have easy access" (Participant-WT18).
	Store promotions (offers half prize influence food selection	" yeah I think I am definitely influenced by promotion so if something has the coloured labels or has a half price sticker or buy one and get one free something like that I do get drown by those things" (Participant-WT23). "they have been so many year bla bla bla so to buy their , the whole box of 30, they were like £ 50 now I understand your thinking £ 50 who spends a £ 50 on a box of chocolate , but I was like wow this is a really good deal and when we buy them they normally 3.58 £ now they working out less then £2 each I will buy them""(Participants-WT15)
	Advertisements Influence food selection	" I think I am a victim of advertisement"(Participant-WT25)
	Accessibility of sweet foods	"so it depends on what I am doing if I am if I am at home I have a lot of snacks like biscuits and chocolates and rubbishy stuff if I am not at home than I don't tend to have that stuff so much I might have if I am not at home during the day I might snack once with something like that biscuits or chocolate bar am if I am at home all day than it's probably three times in the day I will snack." (Participant-WT11) "there is [laughing] a lot of snacks in our office and it's very hard to avoid them , umm probably biscuits mot very many."(Participant-WT19)
	Difficult to know free sugars content of restaurant meals	"aumm I mean I rarely I have takeaways but with takeaways I find it impossible to know how much sugar that was" (Participant-WT19)

	TV programmes or advertisements influence choice of eating	"you know quite a lot of people are influence by TV programme, or government are influenced by researcher who may be lopping behave the industry rather than you know for the good of the population"(Participant-WT19)
	Many foods and drinks have too much of free sugars	" I think there are too many foods and drinks over filled with sugar because it makes them more palatable and cheaper and it will be for example I do try and avoid things which fruit taste syrup and things like that's it seems just cheap White and palatable I would rather not have that kind of stuff."(Participants-WT17)
	Labelling is difficult to understand	"from what I have read it, it's a complicated thing you know how they put it and then the difference in different kind of sugars, the truth is even having read about it I don't' understand that much about so I would rarely look at the labels." (participant WT24).
	Size of a serving on food labelling is difficult to understand	"what isn't clear when umm if you not sure what way to use something you are using so for example like if they give sugar content per 100 grams and then per serving I think it's not always clear how much sugar in each serving because you don't know what size the serving is if that make sense umm so if you buy chocolate bar sometime a serving is actually is only a half of that so if you just glance at it then you will be like ooh that's okay. but actually, if you eat the whole thing then which you would because they are small that for one person [laughing] I think".(participant WT11)
	Food labels are often in a small font	"it's in teeny tiny in a font you can't read so if it was clear I would be happier." (Participants-WT20)
	Limited campaigns about reducing free sugars consumption	"because there is no like you talking about government information knowledge you know we have a government you know campaigns about smoking illness or alcohol abuse or eating too much fat but there is nothing telling me about sugar consumption. "(Participants-WT3)
	Apps not helpful to reduce free sugars intake	"umm it's quite difficult I did try new for a while my fitness pal you know the app you put in your phone so that you can put and it's supervise me while I thought I was being really kind of careful you know when you do my fitness pal you are trying to be healthy umm I got to the point where I was like I am actually going to ignore it what it tells me about sugar because it just went it was away over for me you know I cancel the fruits and things that counted towards I would know umm I could have as many bananas [laughing] and apples that I could and it didn't matter and may be only keep cut of the sugar and stay something like my muesli bar or my soya milk and things like that with added , I am how were my , is that the question how were ?" (Participant-WT15)

	No apps count free sugars content	" that good do yeah I mean I have an app in my phone that kind of does that ummi used for running but also allows you to enter the food that you eating and will break down and shows you that's how much fat you had this is how much protein and this is how much carbs, no sugar on it just carbs fat and protein"(Participant-WT10)
	Food labels need to be wider and big warning number	" to have wide label with black text and say this is the amount of sugar grams and have like to recommended daily intake for men and women and obviously just to make it easy to read if you if I pick something I can see clearly sugar that many grams percentage for women percentage for men okay yeah okay" (Participants-WT20)
	Food labels need to be clearer	
	Food labels need to have Daily recommendation intake of free sugars for both gender	
	Food labels need to be in percentage form	"I would prefer percentages but ...just because they seem easy to understand quickly whereas having to convert you know let's say you are only allowed 10 grams and you used 3.5 grams in this I don't know.(Participants-WT19)
	Food labels needs to have recommended daily intake against percentage of free sugars content.	" so, I think the percentage of the content would be more like a point of interest GP like ooh okay whereas the percentage of your daily is more likely to inform you the choices so if you know that by eating this type well this 50% of something for day then you might think twice about it. this what I want my 50% to be or something else that I want more , aumm so I think the percentage of your daily would be the most useful if you trying to reduce your intake" (participant WT11).
	Food labels need to have total amount of free sugars of a product	" so, they say they give you instead of like half bottle or third of bottle they actually tell you what's in the whole of the bottle, do you know what I mean ?"(participant WT14).
	Food labels state less than a total amount of free sugars of a product	
	Food labels need to be in simple colour scheme	"I guess I mean it's over simplifying where if you have something like said you know there like energy rating on your fridge where you have got 5 and colour coded, so I know some food have say for example, high amount of sugar and that would okay but if every food kind of have something regarding I don't concentration of something so you know if you buy a jar of honey is like 100% am because it wouldn't be a solely negative thing but it will let you make up your mind you know what in each thing you could eat it in in accordingly quantity you know."(participant WT24).

	Food labels font need to be big and in front of products	" well I know there is ingredients it's difficult but, in the front, either got big block and it says sugar fat and protein I mean I don't know about the traffic light system but I think it in the front and it's said there is X amount of grams of sugar in this.... I think because I will be able to look at it straight away I mean you see people I mean I tend to pick up whatever I am buying and turn it offer and have a good look everting thing if am looking at cooking instruction or where is come from , but if it was in the front quite clear and I could see that it was had a lot of added sugar then that would. "(Participants-WT26)
	coding system needs to be publicized and advertised	"well kind of publicised and advertised otherwise I would not think of colours , if it was kind of on TV and it said this is a new system new colour code too help you choose the right foods for you or something that would kind of put it in your brain."(Participants-WT10)
	Coding system needs to be obvious	" I do like to read labels I do like to understand how this is it's a red label and it's say 45 % 45% of what ? and then it's say it's daily intake but then it's in teeny tiny in a font you can't read so if it was clear I would be happier." (Participants-WT20)
	Picture of tooth decay should be on sugary and fizzy drinks	"of decaying teeth, I think I mean it would have to be like on things like other coca cola or you know really high sugar stuff that you really shouldn't be having at all, fine" (participant-WT21)
	Need for Education about free sugars on buses and internet	"yeah I don't have any educational about sugar [laughing]...ooh yeah yeah definitely, you just need like you know bus stop signs or on the side of the bus or in the internet advertisement just you know information ."(Participants-WT3)
	More campaigns free sugars consumption	"because there is no like you talking about government information knowledge you know we have a government you know campaigns about smoking illness or alcohol abuse or eating too much fat but there is nothing telling me about sugar consumption. "(Participants-WT3)
	GPs should educate the public	" I don't see much guidance on sugar intake yes off course I say stuff about sugar based health advice it tend to come in the form of diabetes I think worming of about it that kind of thing but I be I need to stop hinge around in different places or pay more attention or state should have or doctors should provide more information so that people are further advised about it. " (Participants-WT18)
	Need for nutritional classes	"if there is kind of nutrition classes offers cause I mean king's is good with good variety of different training courses, if there is a nutrition one that was offered I would be tempted to do it." (Participants-WT10)
	Need for cheaper prices vegetables	" if fruits and vegetables become cheaper than chocolate crisps and cookies and stuff then I definitely be more attempted to go for the fruits because especially me favourite fruits like cherries and strawberries and they also expensive type so it's same which easier to just like buy something cheap and not healthy. " (Participants-WT14)
	Need for posters in supermarkets and shops	" yeah within supermarket yeah because you want to know you don't have to remember how much in all the foods but if there is a post next to the cereal section how sugars in in all the cereals or you know a post in the fruits and vegan section on what fruits have sugar more than others that kind of stuff , that's easy to recognize you know so you have the information

		and then you can decide what to buy there and then , I think that would be helpful you don't have to remember the stuff all the time. "(participant W21)
	Store product layout	"then like right at the front of the store as soon as you go in me store anyway so that influence me to choose that vegetables….the way supermarkets are laid out for example when I going to Morrison's in north wales where I used to leave, there will be offers for the baked goods so like muffins a pound or buy one and get one free on a pack of flapjacks for example they were very tempting and I did go for it few times and I think offers like that they do influence you." (participant W7)
	Hunger influence my food intake	"especially if you gone into store and you are hungry already"(participant W7)
	Family Income influences free sugars intake	"I think if the food is more expensive than families with low income for example like me or students' budget umm wouldn't buy sugary things even though I don't buy that much sugar "(Participants-WT7)
	Increase the level of recommended daily free sugars intake	" WT21: 5 % sugar is not very much , it depends what , yeah IT: it's opinion we do respect , so would you give me a figure? WT21: of what I think is high sugar content ? IT: yeah WT21: I don't know 20 30 % 25 something like that." (Participants-WT21)

	Caries experience and ill-health	WT2: umm well I. For instance, couple of years ago which I never do, I have a KitKat I bought it from [supermarket] and the first bite it went straight to my teeth and it was really painful. so that tells me how much sugar in little bar of chocolate had, which I never buy chocolate you know. WT20: because I felt really tired and I was looking you know possible symptoms and I have been going to dentist as well every 3 to 6 months because of my filling my root canal that needed to be done and my **dentist** basically made me aware that as well my teeth are suffering because of my diet because may be I am eating too much sugar then I just then I realize again overly tired in the evening I am going to bed 8 or 9 o'clock in the evening may be because I am eating too much sugars and I am like feel very heavy and very tired. I think all these factors like **dentist** telling me that I need to eat a bit more healthy because of my teeth and also me feeling tired I felt I just felt I need to change something so I think the easiest thing to do apart of signing up to the gym is change the way you eat and what you eat so I was quite easy to just like pick healthy things in the supermarket and then like switching to it . I am not going to lie like the first couple of weeks were just absolutely horrible because cutting sugar may be half its just make you feel tired all the time and you just feel like you lose your weight little a bit but it's just felt like okay so its actual working after 2 to 3 weeks so the whole meal start working because I just feel fuller and yeah my porridge definitely made its difference I feel lighter and I feel like you know I feel like beneficial for me.

7.3.2.5. Reflective Motivation

7.3.2.5.1. Social and professional role and identity

Social and professional identities including part experiences, can play an important role in influencing free sugars intake. Quotes number 51 to 52 present examples of relevant quotation for social and professional role and identity as facilitator.

51)" I think it will influence me to change what I eat like I had flu a couple of months ago and I completely lost my appetite and that was a change for short but then when I start to get again I was really careful what I eat I was

really trying to eat healthy food am." (Participants-WT14)

52)" I did go through phases ages ago trying to cut down sugar and I was amazed how much stuff has so much sugar in it like a bottle of orange juice has like a 50% of sugar intake or something I was just I said its impossible. [Laughing] so" (Participant-WT14)

However, some participants stated that identities inherited from their parents and culture can increase the consumption of free sugars. Also, an individual who was a student or on low income may buy cheaper unhealthy foods. Quotes number 53 to 54 present examples of relevant quotation for Social and professional role and identity as barrier. Table 23 presents the remaining subthemes related to social and professional role and identity and examples of quotes.

53)"aa yeah , as a student you trying to get the cheapest you can yeah. " (Participants-WT16)

54) "I think if the food is more expensive than families with low income for example like me or students' budget umm wouldn't buy sugary things even though I don't buy that much sugar "(Participants-WT7)

Table 23: Subthemes and their quotations related to social and professional role and identity (reflective motivation):

Social and professional role and identity (Reflective)	Influence past experience of healthy cooking	"No almost no because no sweet we buy at all we don't buy any desserts we don't buy any cake I mean even if they were in sale I still wouldn't buy them. I think in past because I like to cook I like to bake so certainly I wouldn't buy thing like that pre-prepared. ."(Participants-WT19)
	Professional identity influences free sugars intake	"students budget umm wouldn't buy sugary things even though I don't buy that much sugar "(Participants-WT7)
	Social identity influences free sugars intake	"I am English [laughing]...we are omnivores we eat anything "(Participants-WT17)
	Individual's personality influences free sugars intake.	"yeah , probably if she comes with me she might say let's try this or try that ..... yeah , I am quite flexible , I think." (Participant-WT16). " I am actually incredibly difficult person to be influenced [laughing] in any ways" (Participant-WT4) "I am not going to spend my time adding all of those different things up from the labels so I don't do that I tend to based pure on me what I do know diet and that kind of thing and I suppose it's Intuition." (Participants-WT18)

	Human nature influence free sugars intake	"but you know I am human, now and again if I feeling down I will reach for the chocolate because it's elevate the mode [laughing]."(Participants-WT4)
	individual social class and political identity influence free sugars intake	"I am White middle class liberal I try me food organic food that's Fairtrade all of the clichés yeah I tried I do that other foods that might be some food I will buy like a budget of brand" (Participants-WT18)

7.3.2.5.2. Beliefs about Capabilities

A belief in your own ability to cook food, that it is easy to identify the amount of free sugars in foods, that one is able to quantify free sugars intake, that one is able to know free sugars content by labels, that free sugars content can be found on packaging, and that one can calculate the amount of free sugars consumed per day can contribute to the reduction of free sugars intake. Quotes number 55 and 56 present examples of relevant quotation as facilitator.

55) "no its I would be you know even think of cooking dinner I have my three potatoes and my one pepper and yes I can find the sugar contents of all of these things but I would have to then calculate how much it added up to for example I think for orange juice I have in the morning I can work it out quite easily because what tells me in the pack." (participant WT25)

56)"you know I do like my sweety things I try I restricted myself to have pudding rather than snacks whole day and I know a lot of friends who eat a lot of sugar so I guess that how I can quantify it up for myself."(Participants-WT12)

In contrast, if the beliefs about individual capabilities are weak or the individual is less confident, these beliefs can easily prevent behaviour change to reduce free sugars intake. The following are examples of beliefs that were mentioned by the participants during the interviews: the difficulty of controlling free sugars consumption or reducing free sugars intake, feeling unable to reduce sweet snacks, the ease of getting sweets, laziness, hard to know the free sugars content of meals, difficult to control the influence of advertisements, difficult or impossible to read the labels, and unable to understand the labels. Quotes number 57 to 61 present examples of relevant quotation as barrier. Table 24 presents the remaining subthemes related to beliefs about capabilities and examples of quotes.

57)"I have always I think it might be because I would still find it real hard to give it up like I was having a craving for it still and I thought this is an excuse to given to the craving. yeah and then I just got back to the habit of it and I would like to stop drinking it again." (Participants-WT14).

58)"the truth is even having read about it I don't' understand that much about so I would rarely look at the labels" (Participants-WT24)

59)" probably laziness [laughing]. I just yeah I just don't, I think if I care more by myself and what I was eating then I would probably think about it and I again I do go through phases where I follow a diet plan or something like that but again its rare , day to day I don't care enough I suppose."(Participants-WT10)

60)"so I think I have been exposed to so much television and mainly television but also kind of billboard advertisement for fizzy drinks that its almost an subconscious kind of I don't have control over it any more so or that much control so if hear someone open a can of coco I kind I want a can of coco or if I seen someone drink a can of coco I kind want on" (Participants-WT25).

61)"when I shop if I could see a clear label stating how much sugar its actually in the product but yeah it's not that easy to read at the moment... it's not easy now because you really have to look for it you kind you have to analyse it so." (Participants-WT20)

Table 24: Subthemes and their quotations related to beliefs about capabilities:

Beliefs about Capabilities	Belief easy to identify the amount of free sugars in food when cooking	"when we make food from the basic ingredients than it's reasonable easy because if when we make a cake and they say there is 4 pounds of sugar then we know that there is 4 pounds in there." (Participants-WT17)
	Belief to find out free sugars content in food from the label	"if I look in the labels that I can find some kind of free sugars content" (Participant-WT18)
	Belief to understand food labelling in percentage only	"I would prefer percentages . because they seems easy to understand quickly whereas having to convert you know let's say you are only

		allowed 10 grams and you used 3.5 grams in this I don't know." (Participants-WT19)
	belief to find the free sugars content in food from the packaging	"no, it's I would be you know even think of cooking dinner I have me three potato and me one pepper and yes I can find the sugar contents of all of these things ." (participant WT25)
	Belief it's difficult to control free sugars intake	" IT: can you control yourself ? WT3: umm not really [laughing] it's quite hard it's really difficult yeah it's more difficult than you think." (Participants-WT3)
	Belief can't reduce the intake of sweet snacks	"umm yeah I just I prioritise what I like over the sugar content I think whereas I think you can there are nice meal you can have without sugar. but the snack I really like . IT: you can't ? WT11: I can't get ready of them [laughing]"(Participants-WT11).
	Belief it is easy to get sweets	" it's just so easy to get in and get a bar of chocolate and eat on the tube on the way to home [laughing]"(Participants-WT7)
	Belief it is hard to know the free sugars content of ready meals	"umm I mean I rarely I have takeaways but with takeaways I find it impossible to know how much sugar that was"(Participant-WT19)

7.3.2.5.3. Optimism

Optimism for the best outcome of reduced free sugars intake was associated with interventions. The following examples were described by the participants: food labelling is an important way to select food with low free sugars for the first time, a colour-coding system definitely helps in selecting low-free sugars foods and is useful when comparing two products, the use of the picture of tooth decay is the most effective way to reduce free sugars intake, education about free sugars content of foods is more productive during childhood but will also work with adults, and government restrictions will help the population to reduce free sugars intake. Quotes number 62 to 70 present examples of relevant quotation as facilitator. Table 25 presents the remaining subtheme related to Optimism and examples of quotes.

62) " so, I think labelling would be the key thing aa for me , because I know not everyone does when they go shopping but I do tend to look if something I am buying for the first time , umm so yeah for me personally is the main thing. " (Participants-WT11)

63) " it helps definitely I mean not may be not I don't know about sugar but about pretty much like fats carbohydrates you can see it very clearly and when you pack product and you see all reds you kind of have these like all red you know that a warning sign I should not have this , so definitely it work for a lots of people" (Participants-

WT20)

64) "Definitely yeah well I mean you know naturally looking something red it says you know around everywhere it says stop or warning or alert or something so if you see something is green on it I will draw your eyes first to second attention you will look at it and say oh its healthy its fine and it has some red on it you will know kind of you can compare things better if I am looking at two sets of numbers let say I don't know chicken breast vs chicken thighs for example or different types of mincemeats if I am sticking at two set of numbers it's hard to compare them among each other but if say one had all green and one had three green and two yellow then you could quite easily see that the green one is better and in one part so I think it's very useful." (Participants-WT27)

65) " I think that's definitely is the best way so first it draw your attention to it see the red one then if you are interested like I am it actually pick up exactly why it's actually red that it's the percentage that how many grams what is in the back of it , oh it's not just tomato sauce and herbs it's a bit of long list of other things (Participants-WT7)

66) "will be image of the tooth decay because that. it would be most effective but it will be horrible to be in the supermarket with images of physical negative things." (Participants-WT3)

67) "I think tooth decay image would be the best because if someone can see it then they you know attract the eyes a bit more as opposed to number or colours I don't think. in the way that it will scare me in to thinking that you know me teeth will goanna rot way or you know , I want try to avoid as much as possible if I can you know getting replacement teeth for denture when I get older or anything like that".(Participants-WT22)

68) "IT: education about sugar in food do you think it would help or not ? WT21: yeah massively... in school for kids."(Participants-WT21)

69) " IT: okay education about sugar in foods or meals do you think if you know or aware sugar in food it will help to select ? WT27:

yeah definitely "(Participants-WT27)

70) "IT: okay government restriction in amount of sugar in food or for meal food tax or sugar tax , do you think it will help you ? WT23: yup, definitely it will help me and its certainly will help the nation. (Participants-WT23)

Table 25: Subtheme and its quotations related to Optimism:

Optimism	Education on free sugars in food will work for adult	" IT: okay education about sugar in foods or meals do you think if you know or aware sugar in food it will help to select ? WT27: yeah definitely "(Participants-WT27)

7.3.2.5.4. Beliefs about Consequence

Examples of beliefs about the consequences of free sugars intake that will facilitate the reduction in free sugars consumption include the beliefs that sweets have unhealthy consequences and that naturally occurring sugars in fruits and vegetables and cooking food have healthy consequences. Also, the participants believed that placing a picture of tooth decay on food packaging would help them to reduce free sugars intake and ultimately would prevent the need for dental treatment. Quotes number 71 and 73 present examples of relevant quotation as facilitator.

71)"chocolate and chocolate bars and things like that normally is artificial sugar that's' not very healthy for you so accept. and the good sugar fructose and all the you know natural occurring sugar is in fruits and vegetable then to be perceived as more healthy so yeah my understanding of sugar is definitely."(Participants-WT20)

72)" yeah I think if umm on a day when I done exercise umm it can go either way, either if you feel good about having exercise and so more healthy and avoid snack ...."(Participants-WT11)

73)"I think tooth decay image would be the best because if someone can see it then they you know attract the eyes a bit more as opposed to number or colours I don't think. in the way that it will scare me in

to thinking that you know me teeth will goanna rot way or you know , I want try to avoid as much as possible if I can you know getting replacement teeth for denture when I get older or anything like that".(Participants-WT22)

In contrast, the following examples of such beliefs were expressed by the participants act as a barrier to reduce free sugars intake: the belief that exercise alone is sufficient to control weight without a reduction in food intake, the belief that performing exercise to burn energy means that the individual can eat sugary snacks, the belief that fizzy drinks boost energy. In addition, the selection of food with low calorie content can easily prevent behaviour change to reduce free sugars intake. Quotes number 74 to 76 present examples of relevant quotation as barriers. Table 26 presents the remaining subthemes related to Beliefs about consequence and examples of quotes.

74)"I will have fizzy drinks if I am sleepy may be and just want a little boost" "I think but I know that in moderation these products that high sugar is fine already I belief its fine and I belief that I am using in moderation" (Participants-WT25)
75)"I think if its taste, will put it this way I don't see any point in having umm say low fat low sugar yogurt if it doesn't taste anything" (Participant-WT26)
76)"umm umm I would say I usually go for , its healthy, there is usually one under 500 calories and one is over, so on the days that they have one under 500 calories I really like the look of it I will have that because it's the healthy option again if there is something I don't like either of the options I will go for jack of potato, just because again I don't really like it, but its healthy and I don't like the other two things okay they have." (Participant-WT14)

Table 26: Subthemes and their quotations related to beliefs about consequence:

Beliefs about Consequence	Belief that cooking food has healthy consequences	" I cook quite a lot try to be healthy" (Participants-WT11)
	Belief that fruits with high sugars is bad for teeth	so, I think, fruits with high sugar content umm sweets with high in sugar content also I think carbonate drinks are bad for your teeth umm. "(Participant-WT25)
	Belief that performing exercise without reducing free sugars intake is healthy	"I am trying to lose weight by doing more running and do more fitness exercise so I still eat the same amount of food but I just increase amount of exercise." (Participants-WT3).
	Belief that consuming free sugars is fine as long as doing exercise	" IT: you told me that you parents also told you that is fine if you are young to have sweets. WT16: yeah yeah well in a way I mean if you going to burn it off then it's okay."(Participants-WT16).
	Belief that drinking a lot of fruit juice reduces illness.	" umm so if I ever get if start get cold or feel a bit ill I will always drink a lot of apple juice or eat some oranges juice or take some vitamins or something like that, because I think it might help but I might be too late and then I have to get" (Participants-WT13).
	Belief having free sugars in moderation is okay	"I think but I know that in moderation these products that high sugar is fine already I belief it's fine and I belief that I am using in moderation" (Participants-WT25)
	Belief exercise increases snacking	" ..... or else you feel like you done exercise therefore you can have more like cake and biscuits and things, so definitely it does make difference and I am conscious of falling between sport and what I eat but it's quite unpredictable so." (Participants-WT11)
	Belief only high fat and high calorie foods are bad for me	" I tend to focus on like the calories and fat saturated fats because I know that it's bad for you as well. " (Participant-WT14)
	Belief food labels in percentage of free sugars is helpful in reducing free sugars intake	"yeah I think so I think in percentage it would be a lot better. ... umm so if I pick up a chocolate bar and said that it has got a 30% of your daily sugar probably I will put it start back down and thinking that's really bad , I mean they might do it now but I don't know (Participants-WT13)
	Belief food labels in grams of free sugars is helpful	

	in reducing free sugars intake	
	Belief food labels in grams and percentage of free sugars is helpful in reducing free sugars intake	
	Belief food labelling in grams and percentage helpful with ready meals	"IT: do you think amount of sugar in food amount of sugar in percentage and grams would help you.? WT16: umm yeah probably for the sweeter things. but It wouldn't really help if you are dinner having like umm a beef curry or something it wouldn't be very helpful but if it you are having a doughnut it might be , you might think more about. " (Participants-WT16)
	Belief food labelling in grams and percentage helpful with sugary foods e.g. sweets.	
	Belief presenting free sugars content in percentage or grams are helpful in reducing free sugars intake when comparing two products together	"IT: labels amount of sugar in food do you thing the amount as percentage or grams do you think it will help you I selecting foods with lower sugar? WT11: umm not unless if I was comparing it with something else just a number by itself it wouldn't." (Participants-WT11)
	Belief colour coding system leads to selection of low free sugars food by attracting your attention.	"IT: yes, do you think this would help you to select low sugar? WT27: definitely yeah, well I mean you know naturally looking something red it says you know around everywhere it says stop or warning or alert or something so if you see something is green on it I will draw your eyes first to second attention you will look at it and say oh it's healthy it's fine and it has some red on it you will know kind of you can compare things better if I am looking at two sets of numbers let say I don't know chicken breast vs chicken thighs for example or different types of mincemeats if I am sticking at two set of numbers it's hard to compare them among each other but if say one had all green and one had three green and two yellow then you could quite easily see that the green one is better and in one part so I think it's very useful." (Participants-WT27) "Definitely for example with the jars what I have mentioned quite a lot jars with sauces I stopped choosing that because there was the traffic light labelling system on it which told me exactly how much was in there, so the labels very helpful. " " I think that's definitely is the best way so first it draw your attention to it see the red one then if you are interested like I am it actually pick up exactly why it's actually red that it's the percentage that how many grams what is in the back of it , oh it's not just tomato sauce and herbs it's abet of long list of other things"(Participants-WT7)
	Belief colour coding system leads to selection of low free sugars food by allowing comparison between food products	
	Belief that colour coding leads to selection of low free sugars food assessing the	

	content of the products	
	Belief colour coding leads to more awareness of food choice.	" I find the colour coding is the most informative . on which highlight the facts of how bad it is "(Participants-WT23)
	Belief colour coding won't reduce free sugars intake for a normal person.	"I guess it's abet analogous like the whole smoking situation where they put how bad it's for your lungs in the package and smokers still buy the cigarettes and I think it's the same situation I think like until really you have something wrong with you know until you get diabetes actually you don't take it in consideration umm and I think that the problem with sugar a lots of people including myself we see that in there front they have you know red sticker for like sugar and fat but you still end up buying it so it doesn't really put me off at all. " (Participants-WT22)
	Belief colour coding won't reduce free sugars intake for a normal person.	
	Belief colour coding is not useful when buying or comparing products that have the same free sugars content.	"I don't know I think it will be less useful when you buying if you say I went out to get a chocolate bar if they all red there is not much comparison you can't tell compared with within the chocolate bar which one is the worse ." "it might do umm I guess if there if you have I mean if I was going out to buy a sweet bar a bar of chocolate , there all going to be red so there won't be much sort of different between the bars, you get what I mean. (Participants-WT16)
	Belief that colour coding is a very poor way of presenting information	" no I don't think so because I, you could end up with an awful lot of information on a page on the front in the base so and also if it's says the red and green that doesn't always help, but for me I think I just want the information whether it says green or red that's me I think it's for me to decide whether I think it's." (Participants-WT26)
	Belief an amount of exercise to burn off energy label leads to thinking about free sugars consumption before eating.	" yeah it puts in perspective like I know umm because I do that for myself I know that for example a package of Maltsters is half an hour on exercise bike which is actually quite long time. so, if you are more aware of it more people aware it then I think it will make people to reconsider what they eat because you I think you realise how much hard work it takes to burn something like that off. " (Participants-WT14)
	Belief an amount of exercise to burn off energy label increases awareness of how much exercise you need to do to burn off energy.	" I think it will be an interesting one umm because I have only very recently myself looking at very roughly that sort of thing I know when I am at the gym it's a great because I am using a machine and it will tell me okay I you have just burn a 100 calories ten minutes on the treadmill whatever it is and to be able associated with it yes that could be help may be." (Participants-WT15)

	Belief that an amount of exercise to burn off energy label helps to control sweet snacks	" is actually because now I am going to the gym it's actually make me think about the way about what I am eating in different way but I don't know whether that would necessary stop me from eating I don't I think it would help to me may be control some of other things I eat may be like bar of chocolate for example after the gym"(Participants-WT7) "yeah I would love that. if I have a chocolate bar and they say you have to walk like an hour to burn this off , yeah...because it would make me awake , because I think a lot of people and I do too you just kind you eat and you think ooh that not that's bad ooh that not that's bad and then things kind of stuck up whereas if you want ooh this chocolate bar I have to do that much exercise to burn off you then do that much of exercise you like okay so now I am back to a level I have eaten chocolate bar but I hasn't kind of negatively affected me. "(Participants-WT13) "because you might just say oh who cares I will eat it anyone and I will run for 20 minuets do you see what I mean. it might not be the like but because I go to the gym quite regularly so I know that if I want to eat something in fact I do that now I don't really control what I eat I just exercise more if I am going to have like bad weekend or something you know if I am have a massive meal one night the next day I probably will go to the gym for longer or something like that you know."(Participants-WT21)
	Belief that an amount of exercise to burn off energy label encourages healthy meals.	"possibly the exercise one well I am in two minds about it, on one hand it will be quite interesting to see you can either eat this per or you can't eat whatever this is and exercise 60 minutes to burn it off or you could choice something healthier umm" (Participants-WT10)
	Belief that an amount of exercise to burn off energy label will not influence the choices of a healthy person	"yeah I don't think, I think the problem with me I have always have quite good metabolism I am not sure how damage it will be doing, but internally to me because I don't see it in the outside but I am sure for other people would work you know if you telling them you know you need to do this amount of exercise to burn this amount of calories from what you have consumed but I think for me personally because I have not had any issue of umm it pro won't work for me."(Participants-WT22)
	Belief amount of exercise to burn off energy label is not useful for people who are not performing exercise.	"if says you need to run 100 meters I wouldn't know how to calibrate that with what I do , so it might be of some people but I don't do any running or any formal exercise I just make sure I do a lot of walking , umm it will be less relevant to me. "(Participants-WT18)

	Belief placing a picture of tooth decay on food packaging is acceptable on a sugary drink.	"....you won't be desensitized to it if it's really bad I don't know like like ginger beer or something or coca cola may be it could be good but you have to start some threshold I think ."(Participants-WT27)
	Belief placing a picture of tooth decay on food packaging will reduce free sugars intake	"it will put me off. "(Participant-WT14)
	Belief placing a tooth decay image on food packaging is acceptable in sugary food	"of decaying teeth, I think I mean it would have to be like on things like other coca cola or you know really high sugar stuff that you really shouldn't be having at all, fine " (Participsnt-WT21)
	Believe placing a picture of tooth decay on food packaging has no influence on an individual with no dental decay	"IT: okay alright what about image of dental caries , a tooth with caries, in product , do you think it will help ? WT11: umm I think it will be kind of piercing but personally it wouldn't because they haven't had any caries it wouldn't resonate me personally it wouldn't make me think if I eat that I am going to be that so it won't be nice thing to look at umm but I don't think it will make any difference if I consume that product or not for me personally." (Participants-WT11)
	Belief placing a picture of tooth decay on food packaging will be rejected by the public	" but I am not sure if it will be you know welcomed I"(Participants-WT27)
	Belief placing a picture of tooth decay on food packaging will leads to feeling guilty.	"maybe I mean I don't know I don't know may be I am not sure what kind of food that cause obviously things like smoking are really bad for you you know even if in small amount if you have one cigarette a day still bad for you and there is image are helpful to stay away , but if you had on you know a single biscuit it might be a bit too much or make me feel really guilty if I have any sugar at all it's fine moderation."(Participants-WT27)
	Belief that education about free sugars in food will lead to good results for body and health	" but if have the knowledge about 50% of sugar is bad or 20% you know if have the understanding of sugar and the impact on you know physic, weight , health, fitness than I would definitely take note of you know labels and for me personally percentage will be more effective than colour code."(Participants-WT3)

	Belief that education about free sugars in food enables to make judgement on free sugars intake.	" yes I think would umm I think especially for me realise the different between or perhaps need information about the difference between the different types of sugars umm but then you get all education knowledge about what you are eating and how it all what's there I think is all in the sugar it is useful .I think enable to make judgement on again test whether the sugar is part of the item that I am buying or has been added by the manufactures I and I do like to know what's has sort of part in to it afterwards yeah, so." (Participants-WT26)
	Belief that education about free sugars in food helps to decide on healthy food	" yeah probably I am not sure how much of influence it will have , it probably reinforces the decision I am making already or might help to make better once yes I think it will have a positive effect.". (Participants-WT25)
	Belief that education about free sugars in food has no effect	" umm I think I don't think I am I don't think I know everything about it by any means, but I think relative to the average I am fairly well informed am so I am not sure that that education particularly help me because although I know the risks of consuming a lot sugar still I do , despite that because I prioritizing taste as suppose over the health risk, I think education is really important over all but for me I don't think it will make a big difference."(Participants-WT11)
	Belief that a free sugars or food tax helps the nation to reduce free sugars intake.	IT: okay government restriction in amount of sugar in food or from food tax or sugar tax , do you think it will help you ? WT23: yup definitely, it will help me and it's certainly will help the nation. (Participants-WT23)
	Belief that free sugars or food tax reduces the frequency of free sugars intake.	" suppose me chocolate bar was a pound then I probably think about less a week for example may be to two times a week as opposed to three times a week yeah I think that a very good point that if it's more expensive if it was taxed so that would increase the price, wouldn't it ". (Participants-WT7)
	Belief that high free sugars tax reduces free sugars intake only	" if it was 20% from 50p to I suppose that still 60 p then you know it would start to notice, obviously the problem that keep people saying is that that target that poor people attacks on poor people and probably will still buy it but in less so I mean because I already know I am not sure how it will work but it's a good idea "(Participants-WT27)
	Belief that high free sugars tax has no effect for people with low free sugars consumption	" I think that it, personally I don't think it will affect me too much I don't feel I have a high sugar diet "(Participants-WT17)
	Belief that high free sugars tax has no effect on reducing free sugars intake.	" it's hard to say how much tax it would like how much tax it would be there is 5% tax if you have a chocolate bar that went from 50 p to 55p I don't think people would care that much , I am not against I would say I am for sugar taxing but you know because I am not eating a lots of sugar it won't make difference I suppose because you know if you count coke or whatever it was 60p and then it was a pound suddenly , it doesn't seems important , whereas like good to buy." "(Participants-WT27)

	Belief that high free sugars tax leads to selecting the cheapest sugary food	" umm I think so well , I don't think , so it never gone be sort of a huge amount they put one , so I think if I really want a chocolate bar or fizzy drink I just pay the extra , I don't think it will ever really determine me , but it will make me may be think about it a bit more if they were two drinks I like and one has an extra 20 pens and the other one a bit cheaper okay this may be better for me I will take that one instead. "(Participants-WT13)
	Belief that labelling packaging with free sugars amounts against the recommended level of intake is helpful in selecting food with low free sugars.	" IT: so, because currently in every product there is only amount of sugar with it only do you think this would help ? WT19: I think to have it against the recommended limits definitely help. " (Participants-WT19)
	Belief TV advertisement on low free sugars intake will help in reducing free sugars intake	"me and my boyfriend were talking on this the other day actually, that do you know the adverts the government put on the move more exercise move more adverts like cartoon character I think it's something life or something. there was more adverts on the TV aimed at people not sell them stuff , to tell them this is how much sugar is in this just education , so people everyone watches TV pretty much everyone watches TV so if you put on an adverts prime time where everyone going to see it and it's going to be shock facts like what you said about tooth decay , having a picture of tooth decay associated with a chocolate bar that kind of thing , this is how many is this will that you have to do to burn off this chocolate bar, or this ready meal Bolognese's ready meal which doesn't look like it has sugar on it actually contains this many cup of sugar do you that kind of things, more kind of these adverts are very helpful and would be a good way to educate the public especially something called Talent show ,something everyone going to watch a whole diverse range of people kids to old people as going to watch that show if it's on the adverts on there then that's going to capture a wide range of people attention, that's." (Participants-WT7)
	Belief that the percentage of individual 's daily intake is useful in helping people to think about the food before buying it	"so, I think the percentage of the content would be more like a point of interest GP like ooh okay whereas the percentage of your daily is more likely to inform you the choices so if you knew that by eating this type well this 50% of something for day then you might think twice about it. this what I want me 50% to be or something else that I want more , umm so I think the percentage of your dial would be the most useful if you trying to reduce your intake" (Participants-WT11)

	Belief obvious labelling system helps careful thinking of foods with high free sugars and daily food plan	" umm so if I pick up a chocolate bar and said that it has got a 30% of your daily sugar probably I will put it start back down and thinking that's really bad , I mean they might do it now but I don't know , but I think sort of to make it clearer and more obvious I think I would think more careful about having certain things that have high sugar in and think how would else for me eating for the rest of the day."(Participants-WT11)

7.3.2.5.5.Intentions and Goals

Examples of intentions that were expressed by the participants include the intention not to buy sugary foods, to reduce free sugars intake; to eat healthy food, and to exercise. The participants indicated that their goals were to improve their fitness level and to reduce body weight. Quotes number 77 to 79 and four present examples of relevant quotation for knowledge as facilitator.

77)"I want to get my physical aa my physic in shape so the food I buy you know I am not going to buy ice cream or crisps " (Participants-WT3)

78) " I kind of being in my idea of you know cutting down sugar and eating healthy diet I just wanted to try you know this meal" (Participants-WT20)

79)"I want to lose weight (Participants-WT17)

None of the participants stated that they had an intention or aim to maintain their teeth by reducing free sugars intake. Quotes number 80 and 81 present examples of relevant quotation for knowledge as barrier to oral health. Table 27 presents the remaining subthemes related to Intentions and Goals and examples of quotes.

80)"Again if you decided to go and buy lunch I have already have decided I already know its not be going to a healthy choice I won't really consider it."(Participants-WT25)

81)"umm so because like I play in full as well the aim is to gain weight"(Participants-WT27)

Table 27: Subthemes and their quotations related to intentions and goals:

Intentions	Intention to eat healthy food	"I umm like I say I go to the gym so umm I think you are always a bit more conscious felt what you eat after you have been to the gym because it's just like I have spent so much time and effort and it was so hard I don't want to thought all away by having something really unhealthy to eat now and also if I know that I can't go to the gym one day, I probably wouldn't eat as bad probably make conscious effort to avoid certain foods because I know that I am not exercise them off." (Participants-WT14)
Goals	Goal to get in good physical shape	"I want to get me physical aa me physic in shape so the food I buy you know I am not going to buy ice cream or crisps " (Participants-WT3)

7.3.2.6.Automatic Motivation

7.3.2.6.1. Social and Professional Role and Identity

Social and professional roles and identities may influence reduction of free sugars intake unconsciously through automatic processes and choices. Routine cooking habits and parents' modelling of cooking meals consisting of low-free sugars foods can promote the reduction of free sugars intake to less than 5% of the total energy intake. Quotes number 82 and 83 present examples of relevant quotation as facilitator.

82)"I think in my idea and how I was brought up sandwiches in the morning are not supposed to be too sweet. " (Participants-WT20)

83)" Generally speaking I am creature of habit when it come to my shopping I try to buy I again it does depend on the food stuff I try to buy as far as fruits and veges" (Participants-WT18)

However, habits can act as barriers toward reduce for free sugars intake. For instance, the habit of sharing food with others and annual holidays can also increase the risk of consuming more free sugars. Quotes number 84 and four 85 examples of relevant quotation for knowledge as barrier. Table 28 presents the remaining subthemes related to Social and professional roles and identities and examples of quotes.

84)"I had I started drinking them again when I went on holidays because I thought I am on holiday so it's fine [Laughing] yeah and got back and I said well it's still kind of like holiday feelings so I just have may be one and then umm yeah just got back into the habit."(Participants-WT14)

85)"I said before that my eating habit tend to be shared so when the biscuits get opened I am in there too [laughing]"(Participants-WT17)

Table 28: Subthemes and their quotations related to social and professional roles and identities (automatic motivation):

Social and professional role and identity (Automatic)	Cooking food every day	"normally every day I make my own lunch and it normally a sandwich." (Participants-WT19)
	Craving of free sugars is a habit	"then the chocolate I have I crave it at that time of the day probably because it's the habit because I pass the same shop and because it tastes nice." (Participants-WT7) " I try to get milk, this was always with me since when I was little. it's more tradition and I love biscuits." (Participants-WT6)
	Daily buy sweets	"then the chocolate I have I crave it at that time of the day probably because it's the habit because I pass the same shop and because it tastes nice." (Participants-WT7)
	Education about free sugars in food during childhood develop a good habit for reducing free sugars intake.	" umm about habit start in childhood so if you can educate kids about it in younger umm ."(Participants-WT14)

7.3.2.6.2. Reinforcement

Reinforcement is thought to have a crucial role in facilitating reduced free sugars intake. In the context of this study, reinforcement was associated with interventions as a facilitator of reduced free sugars consumption. Colour-coded labelling reinforces the selection of healthy food. Another example of positive reinforcement is the perceived reward of burning off energy through exercise and education about the effects of free sugars reinforcing decisions about healthy food selection. Quotes number 86 to 88 present examples of relevant quotation as facilitator.

86)"The traffic light it shows you know its gives you positive reinforcement if you get something which is all green you got some rice cake or whatever than or anything fill with some harm or

chicken or whatever you what" (Participants-WT27)

87) "IT: amount of exercise to burn of energy, so if you have a product and they say if you consume this product you would need to run for half of hour to burn your calories , do you think this will help? WT11: yeah I think that's quite a good incentive particularly umm for someone my position who exercises somewhat but not a lot." (Participants-WT11)

88) "IT: okay , education about sugar in food , do you think education about sugar in food would help you to select lower sugar lower foods, foods with lower sugar? WT25: yeah probably I am not sure how much of influence it will have , it probably reinforces the decision I am making already or might help to make better once yes I think it will have a positive effect." (Participants-WT25)

7.3.2.6.3. Emotions

Participants reported both negative and positive emotions associated with the consumption of sweet foods, for example feelings of guilt after eating sweets, enjoying the taste of fruits and drinks without artificial free sugars, love of having fruits with a main meal or as a snack, and dislike of sugary foods. Quotes number 89 to 90 present examples of relevant quotation as facilitator.

89)"yeah I love to have my fruits with my lunch or as a snack I would have it at about in 3 pm."(Participants-WT25)

90) "umm I don't ever buy fizzy drink I don't like them especially umm I don't like coco the one which is not diet because it leaves like often with a lot of fizzy drinks it leaves like a film of roughness on your teeth so don't drink fizzy drink for that reason" (Participants-WT7)

In contrast, emotions can also drive individuals towards increased free sugars consumption, serving as a strong barrier towards behaviour change. The following are examples of emotions that can prevent reduction of free sugars intake to less than 5% of the total energy intake: cravings for fizzy drinks and sweets, love of Coca-Cola, enjoyment of tasty foods, consideration of sweets as treats, the love of a bargain, and

no interest in counting free sugarss in foods. Quotes number 91 to 94 present examples of relevant quotation as barriers.

91)" I love coca cola as it is not coca cola zero because for me it's different taste than I will not go for coca cola zero, just because for me it's a different taste."(Participants-WT6)

92)" if I am going out for a meal I just want something really tasty because it's a treat you don't do it very often do you."(Participants-WT10)

93)"I love bargain I love bargain and if something on sale I would be more like to pay attention." (Participants-WT15)

94) "I have no motivation or interest in calculating sugar content of my food that I prepare myself because I don't consider to be higher in sugar. "(Participants-WT25)

The participants also reported that interventions can stimulate emotions about the reduction in free sugars intake, and these emotions can serve as either a facilitator or a barrier to behaviour change. For example, one of the participants indicated that the use of the picture of tooth decay on the packaging of sugary foods will help him to avoid sugary foods. Quotes number 95 presents examples of relevant quotation as facilitator.

95)"I think tooth decay image would be the best because if someone can see it then they you know attract the eyes a bit more as opposed to number or colours I don't think. in the way that it will scare me in to thinking that you know me teeth will goanna rot way or you know , I want try to avoid as much as possible if I can you know getting replacement teeth for denture when I get older or anything like that".(Participants-WT22)

Interventions can also stimulate negative emotions, which can prevent the reduction of free sugars intake. For example, some participants raised concerns that use of the picture of tooth decay on sugary foods would annoy them, create feelings of guilt and wrongdoing, and prevent their feelings of autonomy. Another example of negative emotion induced by interventions is the negative experience due to apps

(e.g. to many advice that cannot be coped). Quotes number 96 to 99 present examples of relevant quotation as barriers. Table 29 presents the remaining subthemes related to emotions and examples of quotes.

96)"If my breakfast cereal or I don't know or if like if my box of orange juice you know that I have one glass every two days has decaying teeth on it's like a pack of cigarette that would annoying me. Because I feel like I am doing something wrong you know like just I don't need someone to tell whether or rather I should be having a glass of orange juice." (Participsnt-WT21)

97) "maybe I mean I don't know I don't know may be I am not sure what kind of food that cause obviously things like smoking are really bad for you know even if in small amount if you have one cigarette a day still bad for you and there is image are helpful to stay away , but if you had on you know a single biscuit it might be a bit too much or make me feel really guilty if I have any sugar at all its fine moderation but I am not sure if it will be you know welcomed I supposed having graphic images on every products you can have, you won't be desensitized to it if it's really bad I don't know like ginger beer or something or coca cola may be it could be good but you have to start some threshold I think ."(Participants-WT27)

98) "will be image of the tooth decay because that. it would be most effective but it will be horrible to be in the supermarket with images of physical negative things." (Participants-WT3)

99) "When you do my fitness pal you are trying to be healthy umm I got to the point where I was like I am actually going to ignore it what it tells me about sugar because it just went it was away over for me you know I cancel the fruits and things that counted towards I would know umm I could have as many bananas [laughing] and apples that I could and it didn't matter and may be only keep cut of the sugar and stay something like my muesli bar or my soya milk and things like that with added" (Participants-WT15)

Table 29: Subthemes and their quoations related to emotions:

Emotional	feeling of guilty after eating sweets	" I always like I love like kinder Vance all those things though, but after while I feel guilty [laughing]"(Participants-WT6)
	Like the taste of hot drinks without free sugars.	" I only drink tea (not coffee) and I like the taste without sugar."(Participants-WT11)
	Like the taste of cold drinks without free sugars	
	Like the taste of fruits	" I like the taste of apple." (Participants-WT19)
	Crave fizzy drinks	"so umm I think I have been exposed to so much television and mainly television but also kind of billboard advertisement for fizzy drinks that it's almost an subconscious kind of I don't have control over it any more so or that much control so if hear someone open a can of coco I kind I want a can of coco or if I see someone drink a can of coco I kind want on" (Participants-WT25). "fizzy drink I really like fizzy drinks"(Participants-WT12)
	Body craves sweets	"umm it's just what I crave umm me body used to crave something sweet and sugary at some point in the day."(Participants-WT14)
	Picture of tooth decay on packaging lead to guilty feeling.	"...but if you had on you know a single biscuit it might be a bit too much or make me feel really guilty if I have any sugar at all it's fine moderation ."(Participants-WT27)
	Tooth decay image on packaging leads to have no autonomy in a decision.	"if me breakfast cereal or I don't know or if like if me box of orange juice you know that I have one glass every two days has decaying teeth on it's like a pack of cigarette that would annoying me. because I feel like I am doing something wrong you know like just I don't need someone to tell whether or rather I should be having a glass of orange juice." (Participsnt-WT21)
	Enjoying eating sugary snacks	"I snack a lot of sugars and biscuits it was fun I had a fun when I think of biscuits" (Participants-WT7)

In Summary, 12 TDF elements are identified as being relevant to reducing free sugars intake to less than 5% of the total energy: Knowledge; Psychological Skills; Memory, Attention, and Decision Processes; Behavioural Regulation; Physical Skills; Social influence; Environmental context and resources; Social and professional role and identity; Beliefs about Capabilities; Beliefs about Consequence; Intentions and Goals; Reinforcement; and Emotions. Six of the COM-B Model elements which are relevant to reducing free sugars intake to less than 5% of the total energy: Psychological capabilities Physical capabilities Social Opportunities Physical Opportunities; Reflective Motivation; and Automatic Motivation.

7.4.DISCUSSION

The aim of this study was to explore the barriers and faciliatators to behavioural change to reduce free sugars intake related to dental caries in a sample of White UK adults. This goal has been achieved via interviewing of 27 White ethnic participants followed by analysis of the findings with respect to the COM-B model and the TDF domains. The findings from the study captured many factors related to reducing free sugars intake among White ethnic group and the factors are related to the following domains of TDF: Knowledge; Psychological Skills; Memory, Attention, and Decision Processes; Behavioural Regulation; Physical Skills; Social influence; Environmental context and resources; Social and professional role and identity; Beliefs about Capabilities; Beliefs about Consequence; Intentions and Goals; Reinforcement; and Emotions. From all 14 domains of TDF, the only exception to the framework, was that none of the participants' comments could be mapped to the Optimism theme of Motivation. These findings clearly indicated that the six elements of the COM-B model and the 14 domains of the TDF are relevant to behaviour change including reduce free sugars intake.

The findings from the study indicated that the COM-B model and the TDF domains provided a comprehensive framework for the description of the facilitators of and barriers to behaviour change to reducing free sugars intake. Similar findings about the ability of TDF and COM-B Model to capture wider scope of facilitating factors and barriers that affect behaviour reported by previous studies in different fields (Alexander, Brijnath, and Mazza, 2014; Cullinan et al, 2015; Handley et al, 2016). For example, in the study of Cullinan et al, (2015), identified 5 domains related to barriers of doctors toward appropriate prescription of older hospitalized patients, which were detailed analysis and helped them to uncover factors that were not covered by other studies. Another example, Alexander, Brijnath, and Mazza, (2014) concluded that TDF and COM-B have helped them to be aware of many has barriers and enablers to delivery of the Healthy Kids Check and set future plan for intervention.

It is evident from this study and the previous studies that the application of TDF and COM-B framework helped to capture the holistic image of many factors related to behaviour change to the interested groups. The current study identified many factors

related to reducing free sugars intake that were not identified in previous studies (Pawellek et al, 2017; Block et al, 2013; Feng et al, 2016; Terry-McElrath et al, 2012; Battram et al, 2016; Rehm et al, 2008; Emadian et al, 2017; Cortés et al, 2012; Thompson et al, 2009; Park et al, 2012). For instance, Park et al, (2012) identified physical factors that increase the consumption of free sugars. Battram et al, (2016) identified only factors related to environment and context, psychological, physical and social domains in children. The main reason for these studies to have limited understanding of the factors contributing to increase or decrease free sugars intake is none of them is based on psychological models in particular COM-B model and TDF. From the evidence these models help to understand the behaviour from its context in which can help in develop better interventions (Kay et al, 2016; Lipworth, Taylor, and Braithwaite, 2013). As result of limited understanding of the factors contributing to free sugars intake there will be also limited suggestions for interventions, which may ignore important contributor to reduce free sugars intake. As Public Health of England (PHE, 2015) and World Health Organization (WHO,2015) advice that to reduce the risk of free sugars intake , there is a need to apply multi-level common risk approach. BCW with its tools including TDF and COM-B models has the promise to apply this advice through systematic and comprehensive approach.

Some of the factors identified in the current study, an interventions plans have been set for actions by the Public Health of England (2015) to tackle them. The suggested interventions are price promotions; Marketing and advertisement; Portion Size, Provision and sale, training and skills and knowledge. Thus, using systematic and comprehensive psychological models in understanding factors contribute to a behaviour, would help to develop more acceptable interventions to the targeted groups.

7.4.1. Challenges

There were some challenges took place during the collection and analysis and interpretation of the data, however the author has tried his best to minimize the implication of these challenges and issues , through awareness of the challenges and issues associated with the study and Reflexivity. Reflexivity is the acknowledgement of the researcher subjectivity on the individuals participating in the research and research process and findings and trying to minimize subjectivity (Li, 2018; Attia, and Edge, 2017; Berger, 2015; Gilgun, 2008). The reflexivity helps the researcher to carry

out qualitative research in robustness means which include incessant self-reflection during collection, analysis and interpretation of data to minimise the issues and biases associated with the study (Bradbury-Jones, 2007). The researcher in this study applied two principle to minimize subjectivity and challenges during the research process which are : reflection and reflexivity.

Although the researcher is trained in conducting interviews and analysing qualitative data and did tried with a colleague, it was his first time to conduct qualitative interviewing on non his own mother language and environment. This have creating many challenges for the researcher which includes subjectivity from the being of the recruitment process to the data analysis. One of the initially challenges was during the recruitment time, many students (young adults) have applied for the study via email. It was very interesting to see who individuals interesting in the project and helping me to carry out the study. I thought to recruit whoever apply at the being of the recruitment process based on the principle “first come first serve”. I realised that this is one of the subject thoughts in my head. If I carry with this most of the data will be biased with young adults and very limited variation; this would go against the purpose of the study. Therefore, after consulting my supervisor, I avoided the idea of “first come first serve” to increase maximum variation, through selection the needed participants (e.g. verify their age before fixing appointments for interview. This have helped getting more diverse participants as possible as I can. Also, I didn’t rely on only convenience method to recruit and collect the data, I extended to snowballing methods.

Another challenge that I faced, is many females and non-White ethnic groups from the UK have applied for the study. As less experienced researcher in such environment and field, it was initially hard or difficult thoughts to reject any individuals who applied, but I had to challenge my thought and reject many applications who did not fit the study criteria for the sake my PhD project and reducing as much as possible any bias. Also, I have avoided the idea of “first come first serve”. However, in few cases (4) at the day of the interview, participants told me that they were not British, after the interview. Since I discovered this would happened, I started asking any participants before the interview about their ethnicity

again even their told me in the email to minimise any bias. This with the use of previously mentioned techniques, have helped in recruiting participants that met the criteria.

Language and accent were also, challenges during the interview and transcription stages. Because English language and different accents are not my mother language it was very difficult to understand what the participants saying in some cases during the interview including types of British meals and food. I overcome, this challenge by asking participants more clarifications about any relevant words. For example, the first time I heard the word "Treat", I thought its related to treatment or medicine, but after clarification from one of the participants, I understood it was about sweets and food. Also, the speed of speaking with some of the participants was hard to catch up with what they were saying. I overcome this challenge by polite informing the participant that the language is not my first language so I might ask them for any clarification during the interview if needed; they were happy for that. During writing up the transcripts, it was very hard to write the transcript because of the language and accent. I overcome that issue, by using MAXQDA12 Audio speed controller to reduce the speed of the speakers, and re-listen to the audio more than once or twice when needed. Although, I was able to write the transcripts, it took me three to four weeks with review to accomplish the task. However, this lead to an advantage of familiarization of the transcripts.

Another challenge related to the language is some participants could not understand some of the terms used during the interview such as "traffic light" I overcome this challenge by using the terms that participants understood; this would vary between participants. For example, I changed from "traffic light" to "colour coding". Some of the participants particular students were worrying about giving a wrong answer to my question; so, I reassure them that there is not right or wrong answer in my interview not pass or fail; this way allowed participants to participate more with comfort.
Last, as PhD student, time was important factor because I have limited period to achieve my PhD project within four years; this have influenced me to conduct all interviews within two weeks, still I was writing transcription. However, this was not a major issue with deductive approach because themes are already defined.

7.4.2. Strength and limitation

In this study there were strength and some limitations. The strength of the study is the application of theory-based systematic approach to understand the factor contributing to reduce free sugars intake. in addition, to the use of the qualitative interviewing which helped to understand the phenomenon of reducing free sugars intake among the White ethic British adult in depth via their opinion and experience within their context. Also, another important strength of the study is the diversity of the data gathered from various background including range of age, experience level, gender and level of qualifications; this made the collected data very rich. In contrary, there were some limitation or weakness in the study.

One of the anticipated limitations in the study was the possible recruitment of participants from a middle-class. The sample for this study comprised a group with higher than expected levels of education. It is possible that the overrepresentation of middle-class participants may introduce bias in the results, since they may be expected to have lower free sugars intakes than groups with lower levels of formal education. However, in terms of the predictors of free sugars intake this bias may be less important. Future research should be careful to include a broad spectrum of individuals from differing social classes. Fortuitously, some of the participants, some students in particular, were part of a low social class. The second probable limitation in the study, although the author took necessary precaution to avoid any non-British to enrol in the study, the collected data may be contaminated with non-British citizen, however if this could happen it will be very limited. Third limitation was that the authors were unable to assess the free sugars content of the participants' daily meals, as the brands and types of food were not verified in most of the cases. Fourth limitation, the study did not find out about participant opinion and experience on training workers (e.g. caterers) on lower free sugars intake, which according to Public Health of England (PHE,2015) suggested would have positive impact in reducing free sugars intake. Fifth limitation, the use of monetary incentives certainly encouraged participation, particularly among students. However, it may be that the participants had unformed cognitions about free sugars cessation but felt they should answer the questions as set. Thus, the use of incentives may have given greater credence to unformed cognitions than might otherwise have been the case if there had been no incentives. Finally, the study missed some of the UK White ethnicities, such as the

Welsh White ethnicity, which could have additional information and enrich the data. Despite these limitations, we conclude that this study highlighted many crucial factors that influence free sugars intake in this population.

7.5.CONCLUSION

The COM-B model and TDF framework provided an inclusive account of the barriers and facilitators of reducing free sugars intake among White ethnic groups. Although the study had some limitations, we believe that the COM-B model and TDF can be useful for the development of strategies to address specific facilitators and barriers of the implementation of interventions that aim to reduce free sugars intake to less than 5% of the total energy intake in relation to dental caries.

8. Study Three: Development of A Cross Sectional Online Survey for the Quantitative Study

8.1. INTRODUCTION

In the previous section, many barriers and facilitators of behaviour change to reduce free sugars intake to the recommended level among White ethnic groups in the UK, through qualitative interviewing. The use of TDF framework and COM-B model have helped in capturing the factor associated to reduce free sugars intake, the data could help in designing interventions to reduce free sugars intake. However, for intervention to be effective it should be based on theories that can explain and predict behaviours (Sutton, 2004), so selecting the more predictable and understandable constructs within COM-B and TDF of free sugars intake would facilitate the in designing effective interventions. This is one of the reasons to conduct online survey to assess the predictors for reducing free sugars intake among White ethnic group in the UK.

There are different surveys developed to measure the predictors among adults (Astrøm and Okullo, 2004; Kvaavik et al, 2005; Hagger et al 2017). However, these surveys will not be used for the quantitative study of this PhD project for four main reasons. **The first reason**, these surveys applied on different population than the current PhD Project is focus on which are White ethnic groups in the UK. In addition, high chances of utilizing any of these surveys with White ethnic groups in the UK would be less reliable and valid (Onwuegbuzie, Bustamante, and Nelson 2010) and possibly will be resisted by the participants to complete the survey (Keszei et al., 2010). **Second reason**, most of the theories used in these surveys were not comprehensive and systematic as COM-B model and TDF framework along with Behaviour Change Wheel (BCW) framework (Michie, van Stralen and, West, 2011; Michie, & West, 2013). This led to the **third reason,** in which the theories used with the surveys do not assess behaviour within the context including environmental and social factors; COM-B model and TDF framework consider the context in which the behaviour takes place (van der Horst et al., 2007; Michie, van Stralen and, West, 2011; Tak et al., 2011; Michie, & West, 2013). The **fourth reason** is these surveys do not capture the reality and the current context of reducing free sugars among White ethnic groups in the UK, which would negatively affect for the reliability and validity of applying these surveys on the population of this PhD Project (Onwuegbuzie,

Bustamante, and Nelson 2010). Therefore, developing and testing an online survey from the findings from the qualitative study would make the questionnaire more meaningful and user-friendly for the White ethnic groups in the UK (Fink, 2013). Also, the findings from the online survey would be more reliable and valid (Fink, 2013) and this improvement stemmed from the data from interviews of participants' opinions and experiences more useful (O'Brien, 1993) in designing and developing of clinical trials for interventions in the future. Finally, by combining qualitative findings with quantitative findings would result in high quality findings (Atkins et al, 2017). Surveys take different designs including census, cross sectional and longitudinal designs (Mathers, Fox and Hunn, 2009). Census design is used for the entire population, such as Population Census. This type of survey is not applicable or practical for the purpose of quantitative online survey study four because of cost effectiveness (Moser and Kalton, 1990). Longitudinal design is multiple snapshots of data collection over a period of time and it is collected from representative samples; the multiple snapshots mean data collection takes a place more than one interval time (Cook, 1983). Longitudinal design can be cohort which means studying a group of people with same character over time; it could be trend design where data from different sample are repeatedly collected over time (Albery and Munafo, 2008). Cross-sectional is similar to longitudinal design but data collection takes place at one point in time (Albery and Munafo, 2008).

Both cross sectional and longitudinal designs can be used to describe event or attitude of individuals and to find the correlation between two variables this including predictive relation (Mathers, Fox and Hunn, 2009). In addition, data collection in both designs can observational or questionnaire and both can be retrospective and prospective (Mathers, Fox and Hunn, 2009). Both can provide predictive behaviour the future (Prochaska, Wright, and Velicer, 2008), however, longitudinal design is less risk to the problems of confounding factors from inadequate cases matching and control than cross sectional design (Albery and Munafo, 2008). Also, the longitudinal design provides much more accurate measures of predictability because of repeated points of data collection or observation of a behaviour (Moon and Reis, 2004). Moreover, the longitudinal design can be useful in assess causal relationship between two variables and provide with reliable inferences (Cohen, Manion, and Morrison, 2018). For the quantitative study of this PhD project, cross-sectional design will be

used for the following reason. Cross sectional design is inexpensive and quick to administer and apply; also, the design has minimal control effects because of participants contribute only once (Cohen, Manion, and Morrison, 2018). Moreover, as a researcher I would be able to know the percentages of participants in particular groups and inferential statistics which can help to compare between two groups (Cohen, Manion, and Morrison, 2018) (i.e. one of the aims of the quantitative study in this PhD project).

The aim of this chapter of the thesis is to describe and discuss the development and test of the cross sectional online survey of the quantitative study; the quantitative study is presented in the next chapter.

8.1.1. Aim

To develop and test an online survey based on COM-B and TDF domains that can be used to examine the relationship between COM-B and TDF factors related to reduce free sugars intake to the recommended level and the intake of free sugars among White ethnic adults in the UK.

8.2. METHOD

Evidence from this thesis has argued the importance of developing behaviour change interventions from theoretical frameworks that understand the context of the behaviour and predict it. Also, evidence has emerged that no study has used COM-B and TDF to understand and analysis reducing free sugars intake among White ethnic groups in the UK. So far thesis through COM-B model and TDF has understood the factors enhance or hinder the reduction of free sugars intake to the recommend level among White ethnic groups in the UK. The next logic step is the development of a survey that can assess the relation between the influential factors based COM-B TDF constructs and free sugars intake; ultimately identifying the prediction for intervention development. The development of the survey in this thesis was achieved using data from the literature and converting qualitative data, which was gathered from the qualitative interviewing, into a tool that was used by the author to conduct the online survey. As mentioned before, surveys can be used to assess and implement theoretical framework or phenomenon (DeVellis, 2017). The author used Onwuegbuzie, Bustamante, and Nelson's (Onwuegbuzie, Bustamante, and Nelson' 2010) and

DeVellis's (DeVellis, 2017) guidelines on tools development as a manual to develop the survey.

8.2.1. Stage of Development and Test of the Online survey:

The process of developing the online survey took place in logic steps including reviews, polite and creation of the final version of the survey; Figure 17 illustrate the process of developing and testing the online survey for the quantitative study. Explanation of the process is mentioned next to ensure that a reader can understand the process. In the initial stage, main two sources were used to develop the questions for the survey: literature and participants' views from the qualitative study. The literature review has helped to develop demographic, and diet intake measurements sections and participants' views from the qualitative study has helped to shape and form the items that can measure factors influencing reduction of free sugars intake based on TDF domains and COM-B. The format and structure of the final version of the survey is discussed in survey context section of this chapter, however more details of the content of the final version is discussed in the next chapter of the study four (appendix number 13.8.6. presents full version of the pilot survey and appendix number 13.10.6 presents full version of the final survey). Figure 18 presents **the first version** of the survey, examples of questions related to free sugars intake based on TDF domains; this was before mapping items with quotations from the qualitative data. The items were selected from pool of items. The items related to TDF and COM-B model of reducing free sugars intake were formed through a mapping process; this helped to match items to the related subthemes of the qualitative data. Figure number 19 illustrates examples of creating initial items for the survey related to knowledge domain of the TDF.

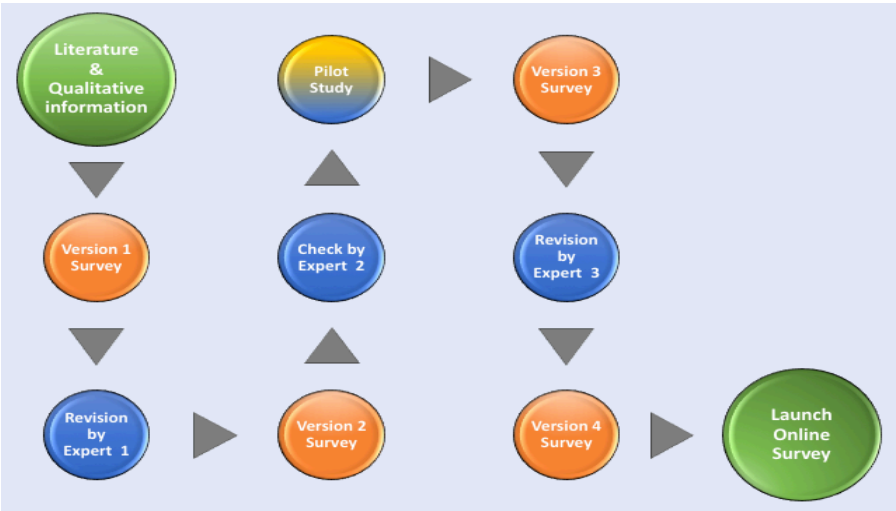

Fig. 17. Process of developing and testing the online survey for the quantitative study

After the development of the first version of the survey, the researcher presented the version to experts (*revision by expert 1*- see quality control of the survey for more details about the experts) in the field to review the version and the appropriate tool for conducting the research; then feedback to the researcher. The experts made some suggestions these include some deletion and rewording of items and adding new items. Also, the scaling of the items was changed. This led to the development of version two of the questions, Figure 20 illustrates **the second version** of the survey examples of questions related to free sugars intake based on TDF domains. The second version of the questionnaire helped to improve content validity of the questions. After that before the pilot stage, the research asked an expert to review *(check by expert 2)* the pilot version of the survey before lunching it online; table 30 list the sections and number of items in the pilot version.

Theme	Statement	Yes	Not sure	No	Not Applicable
Knowledge	I am aware/ understand of food and drinks which can cause caries				
	I am aware/ understand of healthy food for teeth				
	I am aware/ understand of food associated with acidic problems				
	I am aware/ understand of the amount of sugar in food which I eat				
	I am aware/ understand of the when to eat sugary food				
	I am aware/ understand of the term free sugar				
	I am aware/ understand of term added sugar				
	I am aware/ understand of the daily recommended sugar intake.				
	Colour coding helps me to know amount of sugar in a food				
	I am aware/ understand of the colour coding system in food				

Fig.18. The first version of the survey examples of questions related to free sugars intake based on TDF domains.

After approval from the expert of the **pilot version**, it was launched online; this has helped to improve further content validity of the questions (details of the pilot study are mentioned in the pilot section of this chapter). After the pilot study, the researcher used participants' feedback to modify the pilot version and developed a **third version** of the survey; however not every comment was accepted. Huge differences were noticed from the pilot version and the final version of the questionnaire, in particular the scaling of the items and questioning designs of the TDF section of the

questionnaire (for more details please refer to appendix number 13.8.6. and 13.10.6). After development of the third version, it was reviewed by the experts (revision *by expert 3)* and made minor suggestions. A **fourth version** of the survey was developed and lunched after slight modifications were made from the expert review. There was a plan to conduct a second pilot study to enhance content validity, however, the plan was dismissed due to budget and timeframe limitation. Table 30 list the sections and number of items in final version of the survey.

Theme	Related Quotation from Qualititve interview study	Subtheme	Item
Knowledge	"Bad for your teeth aim biscuits sweets I think from what I was told is more about when you eat than what you eat, so if you eating between meal and the stuff is on your teeth all you day that's that's worse but also acidic food and sugar specifically." (Participant-WT24)	Knowledge of food and drinks cause dental caries	I feel I have good knowledge of which food and drinks can cause tooth decay.
	"IT: What food do you consider are healthy for your teeth? WT2: Healthy vegetables fish" (Participant-WT2)	Knowledge of healthy foods for teeth	I feel I have good knowledge of which foods are healthy for teeth.
	"...also acidic food and sugar specifically." (Participant-WT24)	Knowledge of acidic food	I feel I have good knowledge of which foods are acidic.
	" Yeah i know i am have no idea how much sugar is in fruits i couldn't even has it a guess i know there is natural sugar in fruits, but i don't how much of these is bad for you or not."(Participant-WT14)	Knowledge of the amount if sugar in food	I feel I have good knowledge of the amount of sugar in the food I eat.
	"so I think, fruits with high sugar content aam sweets with high in sugar content also i think carbinate drinks are bad for your teeth aam. that what i can think of my top of my head . that what things i asscoiated with and i am careful when i am consuming and i consider them bad for my teeth." my food that i prepare myself becuase i don't consider to be higher in sugar. " (Participant-WT25)	Knowledge of the time for sugary food	I feel I have good knowledge of when to eat sugary food in order to minimise the damage to my teeth.

Fig.19. Illustrate examples of creating initial items for the survey related to knowledge domain of the TDF

Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

Theme	Statement	Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree
Knowledge	I feel I have good knowledge of food and drinks which can cause tooth decay.					
	I feel I have good knowledge of which foods are healthy for teeth.					
	I feel I have good knowledge of which foods are acidic.					
	I feel I have good knowledge of the amount of sugar in food which I eat.					
	I feel I have good knowledge of when eating sugary food will cause least damage to my teeth.					
	I feel I have good knowledge of the term "free sugar".					
	I feel I have good knowledge of the term "added sugar".					
	I feel I have good knowledge of the daily recommended sugar intake.					
	I feel I have good knowledge of the colour coding system in food.					
	I feel I have a good knowledge of the food labelling system.					
	I feel I need more information about the effects of sugar on my body.					
	I feel I need more information about the effects of sugar on my teeth.					

Fig.20. The second version of the survey examples of questions related to free sugars intake based on TDF domains

Fig.21. The pilot version of the survey, examples of questions related to free sugars intake based on TDF domains

Fig.22. The final version of the survey, examples of questions related to free sugars intake based on TDF domains

Table 30: list the sections and number of items in the pilot and final version of the survey:

Criteria	Pilot version	Final version
Number of sections	5	6
Number of questions *	36	205
Sections	Instruction, Consent, Demographic Data, Food intake, and Free sugars intake factors.	Information Sheet, Consent, Instruction, Demographic Data, Food intake, and Free sugars intake factors.

*Based on Qualtrics count, which is subjective to how the questions are framed, please refer to the appendix for more clarification.

8.2.2. Quality Control of the Questionnaire

Quality of the questionnaire affects the outcome results and possible lead to unreliable and invalid findings, if the quality was poor (Gamst et al, 2015). Therefore, ensuring that the quality of the questionnaire at the standard is very crucial to ensure reliable and valid findings that would contribute to positive impact to the society (Gamst et al, 2015). Groves et al, (2004) stated that good quality questionnaire or survey should meet three main criteria, which are: content, cognitive and usability criteria. The content criteria are about assessing the questionnaire in term of asking the right questions in relation to the aim of the study. The cognitive criteria are about assessing respondent's ability to understand the questions and express their answers. The last criterion, which is usability, is about easiness of using the questionnaire by both interviewer and respondents. These criteria can be assessed through five various methods which are: expert reviews; focus group discussions; cognitive interviews, field pre-tests, and randomized or split-ballot experiments (Groves et al, 2004). Due to limited budget and time, the researcher applied three methods for this study: expert reviews; then cognitive interviews and field pretests within the pilot study.

8.2.2.1. Expert Reviews

The experts review step is very crucial in the development of the questionnaire, because they have great experience in surveys in which their contribution would improve the quality of the questionnaire (Groves et al, 2004). The experts evaluate many elements in the questionnaire, including the order, wording, and structure of questions. They also review administrational instructions of the questionnaire and the rules by which the questionnaires are navigated (Groves et al, 2004). For this study, academics and a fellow researcher from KCL, Dental Institute who have experience in the survey and behaviour change field were involved in reviewing the questionnaire. They evaluated many elements of the questionnaire including: the order, wording and structure of questions in relation to the purpose of the survey. Also, they reviewed the level of understanding and clarity of the questionnaire and bias absence; also, the means of administration and launching of the questionnaire. The experts had three main responsibilities, including reviewing the questionnaire, sending feedback to the researcher and checking the questionnaire after modification. The contribution of the

expert has helped to improve the quality of the survey. However, it is not sufficient to hear from the experts only; the target audience are who would fill the survey are equally importance in improving the quality of the survey. Therefore, White ethnic groups from KCL were involved in the assessment of the quality of the questionnaire in a pilot study that is described below.

8.2.2.2. Pilot study

The second method to ensure the quality of the online survey is the use of the pilot study. Pilot study is an investigative research design at small scale which tests methods and procedures feasibility which are planned to be used for a larger scale or to assess the associations and effects between variables which could be important to conducted at large sample (Everitt, 2006). The usefulness of the pilot study is well documented particular for the purpose of feasibility testing (Bell, Whitehead and Julious, 2018); even the Medical Research Council (MRC) highly recommends conducting pilot studies before any clinical trials for designing and evaluating a complex intervention (Craig et al, 2008). For this study the pilot was used to investigate the feasibility of the online survey and the researcher used joint two strategies within this pilot study: Cognitive interviews and Field pretests.

Cognitive interviewing is a process whereby a draft of survey questions is administered by the interviewer in individual interviews and the respondents present their understanding and answering o the questions (Groves et al, 2004). There different strategies to conduct cognitive interviewing; Groves et al, (2004) listed six which are: Concurrent think-aloud; Retrospective think-aloud; Confidence ratings; Paraphrasing; Definitions and probing. Table 31 indicates the definition of the six strategies. The researcher used four of the strategies to conduct the cognitive interviewing, including Concurrent think-aloud, Paraphrasing, Definitions, and Probing. Most of these strategies where applied for the respondents of the pilot study. The cognitive interview of the questions of the questionnaire was carried out within field pre-tests and both were carried out as pilot study.

Table 31: Definition of the six strategies of cognitive interviewing (Groves et al, 2004).

Cognitive interview strategies	Definition
Concurrent think-aloud	Respondents are asked to verbalize their thoughts about the question while answering questions
Retrospective think-aloud	Respondents are asked to justify for their answers either after the answer or at the end of the interview.
Confidence ratings	Respondents are asked to evaluate their confidence in their answers
Paraphrasing	Respondents are asked to paraphrase a question in their own understanding
Definitions	Respondents are asked to provide definitions for key terms in the questions)
Probes	Respondents are asked to answer follow-up questions designed to reveal their response strategies

The field pretest is a process where small number of interviews are conducted by interviewers and applying same sampling methods, recruitment and field procedures to the full-scale survey for the purpose of assessing the applicability to a large scale (Groves et al, 2004). The Pre-testing would help the interviewer to understand any problems would occur in the survey instrument and collection of data, recruitment and selection procedures for respondent; try the best to minimise them in the full scale survey (Groves et al, 2004). During the pretests, the interviewer would make some suggestions to the respondents or ask them to make a suggestion that could minimise any concerns for the larger scales (Groves et al, 2004). The interviewer might conduct some analysis during the pretest to identify for example any missing data or discrepancies with questions (Groves et al, 2004).

For this pilot study, the researcher applied the cognitive interviewing and the pretest to evaluate the practicability of the online survey in term of online implementation; recruitments; procedure; incentives; duration of the completing the survey; phrases and wording; layout and format of the questions, and scaling of the items. The sampling size of the pilot study is 20 participants because it achieved a power of 64 % to detect prevalence problem; simple size 5 to 15 is not recommend because it cannot identify the common problems (Perneger et al, 2014).

The pilot study was ethically approved with the full-scale survey from KCL Research Ethics Minimal Risk Registration Research Ethics Number is **MR/16/17-325**. The sampling methods were purposive sample and same participant criteria as in the qualitative interview. The process of recruitment for this study was via Internet and email based advertisements. This method of recruitment could reach potentially to larger participants at King's College London and outside King's College London to a wide population who can access the Internet and the advertisements for 24 hours any time (Chin and Lee, 2008). However, the downside of using this method of recruitment is the missing of participants who are not accessing the advertisements and rick of having fake participants who don't fulfil the criteria and could lead to sampling biases (Chin and Lee, 2008). The researcher assumed that by using snowballing strategy would help to minimize the first downside. For the second downside, the researcher assumed through oral and email verification the participants could be checked if they meet the selection criteria for the study. Participants were recruited through King's College London based on the sample criteria, which are the same as in qualitative interviewing. Initially, the researcher applied for advertisement for their study recruitment via Research Ethics Office at King's College London. Then, the office posted the advertisement of the study on the King's College London recruitment volunteer webpage for 1 month based on their policy.

Also, they circulated the advertisement via King's College global to accolated the recruitment and made the advertisement more accessible to many students and staff at the college. The advertisement contained the following information: the purpose of the pilot study, the criteria of potential participants, the incentives (to attract participants) and email address of the researcher (SHAR) for further information about the searcher. This method of recruitment allowed recruitment of volunteers without pressure and through informed choice. Voluntarily interested participants who read the advisement on the webpage or email would send an email to the researcher for more information about the study. The researcher sent an information sheet to the interested participants; who agreed with the terms in the information sheet were kindly asked to select the time, date and setting at the convenience of the participants for the interview. In most of the cases the researcher was responsible to book the room for the interview where the participants felt convenience and have privacy. Participants who voluntarily agreed to take part in the study were asked to

sign the consent form and fill out an application and describing their demographic data online at the time of the interview. The filling up of the consent form and the demographic data was completed through self-reporting. A reminder email was sent to the interested participants who did not book appointment to book an appointment for the interview. For those who booked appointment a reminder email was sent to them to remind them about the appointment date and time for the interview.

The pilot study was carried out at individual level. At the beginning of the interview a welcome introduction was provided to each interviewee. This included the follow steps: firstly, a brief description of the purpose of the pilot study. Secondly the interviewees were given a hard copy of information sheet to remind them about the details of the study. Thirdly the interviewer reassured the interviewees that all information that is collected and processed about them during the course of the research is be kept strictly confidential and done by the interviewer (SHAR). Also, the data is protected by our University procedures. Fourthly, the interviewer restated that the interview would be tape recorded and transcribed by the interviewer (SHAR) after they consent the procedure.

The tape recording was mention in the consent form and in the information sheet. After confirmation from the interviewees to proceed with interview, the respondent would fill the consent form online with survey and proceed with filling the online survey. The interviewer would use the four strategies of cognitive interviewing to assess the respondent understand of the questions between a small number of questions. Also, he would ask about the structure and scaling of the items and other criteria mentioned before of the online survey. The duration of each interview was set to a maximum of 60 minutes; however, there were variations among the interviews with times ranging from 20 to 90 minutes. This is because some of the interviewees were telling detailed information and allocated time; others were providing important but short and not willing to answer more. During the interviews, any queries and questions were clarified. At the end of each interview, the interviewer acknowledged the interviewee for their time and a £20 amazon voucher was given to the interviewee as an appreciation. The interviews were conducted at the Dental Institute, floor 18, Guy's Hospital Tower in London, which was suitable for the interviewees.

After the interviews the researcher reviewed all the comments made by the participants; the following general changes were made after assessing participant comment and literature review:

- All participants were happy about £ 20 incentive for the length of the survey.
- Some of the Scaling change from attitude to frequency
- Head of the scaling has been repeated in most of the long questions
- Adding two more scales (Neither agree or disagree and Not applicable
- Adding more items
- Delete some items Misleading or incorrect presupposition
- Merge some of the items
- Add examples in some of the items
- Making some of the items more focused rather than general e.g. influence
- Modify the Ethnicity criteria in the advertisement and in the online survey
- Information sheet and consent form were added online.
- Define some of terms within items or questions to ensure consistency among participant.
- Replacing some of the terms.
- Adding more items for dental filling history.
- Scaling of items increased to 7 scales in most of the questions based on Likert scale
- Using BBC social Class Calculator link to identify the social class of participant. More details of the calculator is discussed in the next chapter

8.2.3. Survey Content and Format:

The content and format of the final version of the survey is discussed in detail in the next chapter. Generally, the content of the final survey has following main sections:

  - Information sheet Agreement of participating in the pilot
  - Consent
  - Instruction sheet
  - Demographic

- Food and drink intake
- Reducing Free sugars intake

The questions were into two forms: close-ended questions in the form of rating scale (Likert scale) and one open-ended question with an option for further information. The questions were arranged in a way to avoid any effects of memorising by the participants (Fink, 2013). Reducing free sugars intake measurements were developed by the researcher and were based on TDF domains structure. For food intake measurement the researcher used items from FFQ that measure free sugars related food. More details about the format and content of the survey can be found in the next chapter.

8.2.4. Implementation of the Survey

There are different methods to implement the survey; table 32 presents the main methods used to implement the survey and their advantages and disadvantages. The researcher selected web-based or internet-based approach to implement because it is cheap and quick and easy to develop and deploy (Manfreda and Vehovar, 2007; Hageman et al, 2015). Also, it does not need any specific requirements, useful for multifaceted surveys and participant anonymity is maintained (Manfreda and Vehovar, 2007; Hageman et al, 2015). However, the application of the web-based or online has disadvantages: could be difficult to get in touch with target samples because of internet access, respondents need to have experience with computer, researcher may find it difficult to verify the respondents if they are what they claim Hageman et al, 2015). However, some of the limitations have been addressed by the researcher through the use of Qualtrics platform a web-based online survey (Qualtrics, 2018). Qualtrics is platform that is user-friendly through mobile phone and webpage; this extends the accessibility of the survey related to the topic (Qualtrics, 2018). Also, it can help the researcher to a limited extend to verify some claims made by respondents (e.g. IP address); the Qualtrics platform is more secure than the other web-based survey designer (Qualtrics, 2018).

Table 32: Main methods used to implement the survey and their advantages and disadvantages (Hageman et al, 2015):

Method of implementation	Advantaged	Disadvantage
Face-to-face interviews (Loosveldt, 2007)	Permits explanation of questions; explore and complete responses; ensure respondent who they are; permit personal observations	Expensive; need training interviewer; interviewer bias.
Telephone surveys (Steeh, 2007)	Less expensive than Face-to-face interviews	Need data entry; difficult to ensure the sampled individual is eligible
Self-administered (Leeuw and Hox, 2007)	Less biased to responses	**No** explanation of questions; **No** explore and complete responses; **No** observations
Internet surveys (Manfreda and Vehovar, 2007)	Cheap; quick development; distribution; no specific requirements are need; anonymous; Effect for complex survey	Difficult to get in touch with target samples because of internet access, respondents need to have experience with computer, researcher may find it difficult to verify the respondents if they are what they claim
IVR: Interactive Voice Response (Steiger and Conroy, 2007)	No interviewer is needed; cheap; any time data collection	Depend on touch-tone telephone; low response rate; not applicable for population level.
Computer Assistant Self-Interview (Hageman et al, 2015)	Less prone to social desirability; cheaper than involve interviewer	Contact might not be available; Low response rate; biased sample.
Mixed mode surveys (Leeuw, Dillman and Hox, 2007)	Less error due to multiple data collection methods; less cost;	Complex and may be problematic

9. Study Four: Association Between Consumption of Free Sugars and Theoretical Domains Framework Factors of Reducing Free sugars intake Among White Ethnicity in the UK

9.1. INRODUCTION

This thesis until now, has assessed a body of evidence that examined the effect of free sugars intake on body and teeth and the preventive approaches taken by oral health and public health professionals to reduce the impact and intake of free sugars among adults' population. In addition, it argued the important also to focus more interventions and clinical trials on adults' population to reduce free sugars intake. Moreover, the thesis, has systematically assessed the effectiveness of interventions based psychological models to reduce free sugars intake among adults and found no study has applied the Behaviour Change Wheel framework and its tools to reduce free sugars intake among White ethnic adults in the UK. Therefore, the thesis has applied the Behaviour Change Wheel framework and its tools to reduce free sugars intake among White ethnic adults in the UK, through first empirical study (chapter seven). The study aimed to understand the barriers and facilitating factors towards reducing the intake of free sugars to less than 5% of the total energy intake among White ethnic adults in the UK, using COM-B Model and TDF (Cane, O'Connor and Michie, 2012). The findings from the study indicate that many factors contribute to reducing free sugars intake and should be considered before planning to design any interventions or clinical trials to reduce free sugars intake among White ethnic groups. Also, the finding from the study revealed the importance of applying a comprehensive behaviour change framework like COM-B model and TDF to understand the possibility of reducing free sugars intake; this is because the framework can capture the complexity of a given behaviour which is nature of any behaviour to be complex (Cane, O'Connor and Michie, 2012).

Based on the recommendation of Atkins et al (2017) and to further assess the relation between the factors influence reduce free sugars intake based on TDF and COM-B, and the consumption of free sugars among White ethic groups, an online survey was developed based on TDF and COM-B which can assess the relationship. Findings from the literature, qualitative interviewing and pilot study have contributed to the development initial tested and validated the online survey that can assess the relation

between the factors influence reduce free sugars intake and the consumption of free sugars among White ethic groups. Previous studies have used different psychological models to assess predictors towards free sugars intake such us Astrøm, and Okullo (2004) and Kvaavik et al (2005) used Theory of Planned Behaviour and Hagger et al (2017) used an integrated dual-process, dual-phase model. As discussed previously, there were differences between the constructs within these models in predicting free sugars intake and predictability of the free sugars intake was also achieved beyond the psychosocial models such as gender and dental caries experiences. Also, the thesis critically argued that the models used did not capture the complexity of free sugars intake as Theoretical Domains Framework and COM-B model (Cane, O'Connor and Michie, 2012, Al Rawahi, Asimakopoulou, Newton, 2018). To the researcher's knowledge, no studies have addressed the association between the factors influence reduce free sugars intake and the consumption of free sugars among White ethic groups using Theoretical Domains Framework (TDF) and COM-B model (Cane, O'Connor and Michie, 2012).

9.1.1. Aim

There are four aims for this fourth study. The first aim is to assess the differences between high, low free sugars intake and groups in the demographic data in the TDF domains of reducing free sugars intakes. The Second aim is to examine the association between the two levels of free sugars intake and the demographic groups among White ethnic groups in the UK. Third aim is to test the correlation between free sugars intake and the TDF domains of reducing free sugars intake. Fourth aim is to assess the predictability of TDF domains for reducing free sugars intake and dental filling toward free sugars intake data among White ethnic adults in the UK.

9.1.2. Objectives

- To describe the demographic and characteristics of the participants of this study.
- To identify high and low free sugars intake among White ethnic groups in the UK using measures of sugarsy food from validated Food Frequency Questionnaire (Bingham et al, 1995; McKeown et al, 2001; Day et al, 2001).
- To test the differences among high and lower free sugars intake White ethnic

groups in the UK in the factors related to reducing free sugars intake based on TDF and COM-B model.

- To test the differences among the groups within each demographic data in the factors related to reducing free sugarss intake based on TDF and COM-B model.
- To test the association between groups of free sugarss intake (high and lower) and the demographic data.
- To assess the correlation between the factors related to reducing free sugars intake based on TDF and COM-B model and free sugars intake.
- To assess the prediction of TDF factors on free sugars intake
- To assess the differences between genders in the factors predicting free sugars intake.
- To assess the difference between participants with dental filling and without dental filling in the factors predicting free sugars intake.
- To assess the prediction of dental filling status, on free sugarss intake.

9.2. METHODS

For the aims of the current study, the quantitative method was applied to assess the characteristics of a group of community; more importantly is to determine any statistical association between two variables through examining the relationship between them (Neuman, 2000). Also, the quantitative approach can be used to find out the causal relationship between two variables (Neuman, 2000); this is not relevant to the aims of the current study. There are many benefits of using quantitative methods, this type of research method consumes less time and allow larger data collections in short period compare with qualitative research methods (Johnson and Onwuegbuzie, 2004). Also, generalisability is achievable with quantitative method depending on the sample method and design (Bowling, 2014). Moreover, the benefits of quantitative goes beyond than data collection, the analysis within quantitative research methods is less time consuming than the analysis in analysing qualitative, because of software is available for use by researchers (e.g. SPSS) which lead to much accurate and quick analysis of large data (Johnson & Christensen, 2004). Equally, the quantitative method has disadvantages; this method does not provide

similar in-depth analysis like qualitative method (Tunis et al., 2003). In addition, some of the quantitative designs such as clinical trials have comprehensive, complex and specific inclusion criteria which are necessary and may require further testing for studies with less complex criteria (Tunis et al., 2003).

9.2.1. Research Design

This study employed an online cross-sectional survey study design to achieve the three aims related to behavioural change to reduce the intake of free sugars among White ethnic adults in the UK. The reasons for selecting the online cross-sectional survey were discussed in the previous chapter (chapter eight).

9.2.2. Ethical Approval and Consent

This study was ethically approved with the full-scale survey from KCL Research Ethics Minimal Risk Registration Research Ethics Number is **MR/16/17-325**. Written informed consent will be obtained for each participant following perusal of an explanation of the research details.

9.2.3. Sample population and Frame

Based on the literature, the sample of this study comprised White ethnic adults aged 18 and over. For the purposes of this study, the White ethnic adults invited to take part were those individuals who live in the UK, spoke English, and identified themselves as White; ethnicity is considered to be a form of self-identification (Leung and Stanner, 2011). Therefore, based on these criteria, the White ethnic adults would be: Scottish, English, Welsh, Northern Irish, British Irish, Gypsy or Traveller-in (Office for National Statistics, 2015; P8.). Also, the samples should be free from systemic or local diseases (e.g., diabetes, as these conditions may affect decision making about free sugars intake and vary from the general population) and should be mentally sound. Any participant who don't fulfil the above criteria would be excluded such as under 18 years will be excluded.

After setting the criteria for the population sample, a sample frame, which is the source where the sample will be selected and recruited, was selected (Ritchie, Lewis, and El am, 2003). There are different sample frames including; area frames, variety of lists frames and random-digit-dialling (RDD) (Hall, 2008). In the qualitative interviewing, the sample frame was based on the area frame in particular "flow

population" method, which involves a process where samples are purposefully selected from a particular site or setting which staff and students of King's College London (Ritchie, Lewis, El am, 2003). In this study, the sample frame is based variety of lists because the research design is based on web survey (Hall, 2008). This means a variety of list to contact participants via emails and ask them to fill the online survey (Hall, 2008). This method would allow including participants from of King's College London and have more coverage.

9.2.4.Sample Size

The sample size for this study is based on comparing the TFD scores of high free sugars intake and low free sugars intake participants using independent samples t test. A study with 80% power, assuming an effect size of 0.4 will require a total sample of 200 (100 per group) to test the average difference in knowledge scores (or of all TDF domains separately) between the two groups using two tailed test at 5% level of significance. The power calculation was carried out using G power version 3.1.5.

9.2.5. Sampling Methods

There are two ways to conduct survey either through census or sampling (Sue and Ritter, 2007). Census is conducting survey by involving every individual of the targeted population, which required more resources (Sue and Ritter, 2007). However, this way of conducting survey is impractical and inefficient for the purposes of the current study, because it will need more resources that are unnecessary. Alternatively, sampling would be more practical and efficient because only selected samples from the entire targeted population participant in the survey which required less time and less resources to conduct the survey (Cochran, 1977). There are two main sampling methods: probability and non-probability sampling methods (Fink, 2017). Generally, probability sampling methods are associated with random selection of participants and non-probability sampling methods are associated with non-random selection of participants; random sampling leads to more representation from the targeted populations (Fink, 2017). There are different strategies for probability sampling methods include: Simple random; Systematic random; and Stratified random (Fowler, and Floyd, 2014). Also, there are different strategies for non-probability sampling methods, including Convenience, Volunteer opt-in panel, and Snowball (Fowler, and Floyd, 2014).

The sampling strategies can be mixed (Teddlie and Yu, 2007); which is the case with the current study. The researcher applied a volunteer opt-in panels method based on the stratified simple random sampling and snowballing strategies (Sue and Ritter, 2007). Volunteers opt-in list method means individuals participate in a study voluntarily through responding to or recruited via advertisements (e.g. web based) (Sue and Ritter, 2007). For the current study, participants responded to two web-based advertisement: KCL website and Call for Participants. The stratified simple random sampling was applied in two stages. The first stage was to divide the list into the following five groups (strata): KCL staff, KCL students, Call for Participants staff, Call for Participants students, others. The second stage is the application of simple random sampling from each group. This strategy helped to minimize the recruitment of many KCL students. In addition, snowballing strategy to accelerate recruitments of staff in particular male. The sampling method used with the strategies allows for representation from White ethnic background student and staff and female and male compared with the qualitative interviewing study.

9.2.6. Survey Development

The process of development and testing the online cross-sectional survey were discussed in details in the previous chapter (chapter eight).

9.2.7. Survey Context

As mentioned in the previous chapter (eight), the final online survey was developed from the literature review, expert opinion, white ethnic groups' opinions and experience from the qualitative study and respondents from the pilot study. The final version of the online survey consists of seven main sections of which six (1-4,6, and 7) were developed and designed by the researcher. Questions in section three were extracted from validated Food Frequency Questionnaire (see appendix number 13.10.16 for detailed questions). The **first section** of the survey, consists of information about the survey including the purpose of the survey expectation form the respondents, time to complete the survey, confidentiality and rewards for participating in the survey and at the end there is two options for the interested individual either to agree or disagree to participant in the survey. If the individual accepts to participate,

s(he) can move to next section, however if s(he) rejects to participant then s(he) will be forwarded to the end of the survey and appreciate their time. The **second section** consists of consent form and the **third section** contains instruction sheet which information that guide the participants to answer the questionnaire. If the individual accepts to all terms of the consent form, then s(he) can move to next section, however if s(he) rejects all terms of the consent form then s(he) will be forwarded to the end of the survey and appreciate their time.

The **fourth section** is about demographic data and it consist of 15 questions which related to the following demographic information: nationality, ethnicity, health status, employment status, age, gender, qualifications, dental filling status, dental filling history, height and weight, current health status, household status, social class status and place of living in the UK. If the participants in the nationality, ethnicity, and health status questions do not meet the inclusion criteria mentioned in the section 9.2.3., then they will be excluded to the end of the survey and acknowledged with statement. However, if they meet the criteria, then they can move to the next sections. It is important to highlight here, that the participants were not aware of the selection criteria to minimize recruitment and sample biases which could lead to data contamination. For the social class status question, a link is provided for participants that directs them to BBC The Great British class calculator: What class are you? (Savage et al, 2013; BBC, 2013). This is an online social class survey made by BBC that has been validated and supported by social scientists (Savage et al, 2013). Participants answer questions related to their income household and other measure and at the end the website define the social class of the individuals based on their answers. Table 33 presents the new seven BBC social classes and their definition. There is an anticipated bias by using the link method , that some participants may select a social class without going through BBC link, which would affect the results in relation to the social class.

Table 33: The BBC Social Classes and their definition (Savage et al, 2013):

Social Classes	Description
Elite	Very high economic capital (especially savings), high social capital, very high highbrow cultural capital
Established middle class	High economic capital, high status of mean contacts, high highbrow and emerging cultural capital
Technical middle class	High economic capital, very high mean social contacts, but relatively few contacts reported, moderate cultural capital
New affluent workers	Moderately good economic capital, moderately poor mean score of social contacts, though high range, moderate highbrow but good emerging cultural capital
Traditional working class	Moderately poor economic capital, though with reasonable house price, few social contacts, low highbrow and emerging cultural capital
Emergent service workers	Moderately poor economic capital, though with reasonable household income, moderate social contacts, high emerging (but low highbrow) cultural capital
Precariat	Poor economic capital, and the lowest scores on every other criterion

In this section, the researcher used two types of questions were used, these are: multiple choice and slider questions. Participants in the multiple-choice questions, select one or two option, depending on the question been asked. The slider type questions were applied in height and weight questions, so participants allocate a bar on the slide according to their height and weight status. The **fifth section** is about sugary diet intake, where participants indicate their average intake of a range of sugary foods and drinks in last year. This section consists of 44 items and 6 questions that at the end will feed on the measurement of free sugars intakes per individual. The questions within this section were extracted from previously Validated full Food Frequency Questionnaire (FFQ) from the EPIC-Norfolk Food Frequency Questionnaire (University of Cambridge, 2017). Although, there is a short form food frequency questionnaire, it was limited and general in the content related to sugary food (Cleghorn et al, 2010), which means that many sugary foods and drinks are

missing from the questionnaire; this don't serve the purpose of the current study. Therefore, developing sugary food list from FFQ from EPIC-questionnaire was useful for the current study because it was detailed list that covers most of the sugary foods and drinks in the market, which can provide with more accurate data for analysis. Although the list is useful for analysis, there were few food staff needs updates. For example, the colour code of some types of milks was outdated compared to the milk available in the market, which could create a bit of confusion, but many of the participants were aware of the issue. The researcher used the as sugary food list from FFQ from EPIC-questionnaire because it was validated questionnaire and time was not sufficient for the researcher to develop a new fresh list and validated for the current study. A recommendation for FFQ from EPIC-questionnaire to be updated would be more useful than the current content. In this section, two types of questions were used: multiple choice, and add a text in the form of matrix table which is same as in FFQ from EPIC-questionnaire.

The **sixth section,** is about questions of factors that influence reducing free sugars intakes and organized in the sections based on COM-B model. There are 16 domains of TDF that are associated with COM-B Model; each domain has a number of questions or items. Most of the questions are based on the multiple choice Likert scale and very few questions were based on add a text. Participant would select an option based on their response to the question. Further details about the scales and measurements used in this section are discussed in the main outcome measures section.

The **seventh section,** which is the last section in the questionnaire, the participants are asked to enter their official email address to receive e-Amazon gift card, after successful completing the survey. As mentioned previously that the survey of the study was implemented on Qualtrics Web-based survey. There was a concern about the length of the questionnaire (about 207 questions), which may decrease participants' interest and ability to complete the questionnaire. However, this not a major concern for this study because the participants can complete the survey at any time suit them without being physical available with the researcher; also, they were given a week to complete the question from the date their started to answer the questions which would depend on individual's circumstances.

9.2.8. Survey Measures

There are a range measures which were used in the analysis in the current study in the demographic, sugary food intake and factors related to reduce free sugars intake based on COM-B model sections. These measures were included in this study based on the previous study (chapter eight) and literature. Twelve measures were identified in the demographic section, one for the sugary food intake section and 16 for factors related to reducing free sugars intake based on the COM-B model section. Below are the description of the measures used in the three sections.

9.2.8.1. Demographic Section

There are 12 measures for demographic sections: ethnicity, employment, age, gender, qualifications, dental fillings status, dental filling history, Body Mass Index (BMI), current health, house hold, social class and place of living. Ethnicity backgrounds of the participants were determined with a question on a nominal measurement list of all ethnicity backgrounds in the UK. Participants were asked to select their ethnic background and if they do not meet the inclusion criteria of ethnicity, they will be automatically excluded from the study. Therefore, measurement related to White ethnicity was only used in the current study. Employment, gender, dental fillings status, household, and place of living data were measured through nominal measurement for each. Participants were asked to select one of the options in each of the section that matches with their background. Each section had one question only and all were included as measurement in the study. Age, qualifications, dental filling history, current health, and social class data were measured through ordinal measurements. Participants were asked to select one of the options in each of the section that matches with their background. Each section had one question only and all were included as measurement in the study. BMI data was measured through computing height data with weight data for each participant by the researcher; this means that two items are associated with BMI. Two types of measurements were created for the BMI by the researcher: the first is a scale which is a continuous measurement of BMI and the second is an ordinal or classification of BMI based on The International Classification of adult underweight, overweight and obesity (WHO, 2018).

9.2.8.1. Sugary Food Intake Section

Two measurements were used for free sugars intake: continuous scale and categorical measurement. The continuous scale of free sugars intake per day was developed in two stages: the first stage was a creation of the continuous scale of different types of free sugars from the 44 items based on ordinal scale of 9 options (*Never or less than once/ month……. 6+ per day*), four nominal questions and two list questions (University of Cambridge, 2017). This creation was done by an expert (MAA) and one of the authors of the EPIC-Norfolk Food Frequency Questionnaire (University of Cambridge, 2017) using a FETA tool, which is designed to calculate diet or nutrition intake (Mulligan et al, 2013). The researcher could not use the tool because the tool was not compatible with MacBook bro laptop, so the researcher asked (MAA) to process the data from the question to get the scale of free sugars intake of each participant. In the second stage (the creation of contiguous scale), the researcher calculated the total free sugars intake of each participant, which led to the development of the continuous scale. This stage was important to exclude sugars that were not defined as free sugars. After the development of the proper continuous scale of free sugars intake per day, the researcher used the scale to develop categorical measurement of two groups: high (above 30g of free sugars intake per day) and low (equally or below to 30g of free sugars intake per day) for analysis (SACN, 2015). This was done through using compute in SPSS version 24. So, two measurements were used in the analysis: continuous and categorical measurements.

9.2.8.1. Factors of reducing Free sugars Intake

Measurements of factors of reducing free sugars intake were based on the 16 domains mapped with six components of COM-B model. According to Cane, O'Conner and Michie (2012), 17 domains of TDF are mapped the six components of COM-B model. However, for this study optimism domains which is mapped with automatic motivation of COM-B model is missing because this domain was not identified from the qualitative interviewing study (Al Rawahi, Asimakopoulou, and Newton, 2018) nor during the study three of this PhD project. Four measures were identified as essential for the psychological capability construct, one measure for physical capability construct, one measure for social opportunity, one measure for physical opportunity, six measures for reflective motivation and three measures for automatic motivation.

Diet intake measurement: number of scales in each element of COM-B computing for scale and number of items for each scale.
COM-B & TDF constructs related to reduce free sugars intake

9.2.8.1.1. Psychological Capability (four measures)

Knowledge was measured with 28-item knowledge of reducing free sugars intake scale that was developed from the study three. The items were assessing many aspects of knowledge to reduce free sugars intakes such as: cariogenic food, colour coding, food labelling. Measurements of knowledge were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The Knowledge continuous scale was developed from computing the 28 items.
Psychological ability was measured with 10-item psychological skills of reducing free sugars intake scale that was developed from the study three. The items were assessing 10 aspects of psychological skills to reduce free sugars intakes such as: easiness of calculating daily free sugars intake. Measurements of psychological ability were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The psychological ability continuous scale was developed from computing the 10 items.

Memory, attention, and decision processes were measured with a 41-item knowledge of reducing free sugars intake scale that was developed from the study three. The items were assessing many aspects of memory, attention and decision processes to reduce free sugars intakes such as: decision making of taking low free sugars content foods. Measurements of memory, attention and decision processes were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The memory, attention and decision processes continuous scale was developed from computing the 41 items.
Behavioural regulation was measured with 2-item behavioural regulation of reducing free sugars intake scale that was developed from the study three. The items were assessing two aspects of behavioural regulation to reduce free sugars intakes such as: action plan for daily free sugars intake. Measurements of behavioural regulation were

in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The behavioural regulation continuous scale was developed from computing the 2 items

9.2.8.1.2. Physical Capability (one measure)

Physical ability was measured with 5-item physical skills of reducing free sugars intake scale that was developed from the study three. The items were assessing five aspects of physical skills to reduce free sugars intakes including: cariogenic food, colour coding, food labelling. Measurements of physical ability were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The physical ability continuous scale was developed from computing the 5 items

9.2.8.1.3. Social Opportunity (one measure)

Social influences were measured with 10-item social influences of reducing free sugars intake scale that was developed from the study three. The items were assessing 10 aspects of social influences to reduce free sugars intakes such as: family influence on the intake of free sugars intake. Measurements of social influences were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The social influences continuous scale was developed from computing the 10 items

9.2.8.1.4. Physical Opportunity (one measure)

Environmental context and resources were measured with 50-item environmental context and resources of reducing free sugars intake scale that was developed from the study three. The items were assessing many aspects of environmental context and resources to reduce free sugars intakes such as: cost of the healthy food. Measurements of environmental context and resources were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The environmental context and resources continuous scale was developed from computing the 50 items

9.2.8.1.5. Reflective Motivation (six measures)

Beliefs about capabilities were measured with 16-item beliefs about capabilities of reducing free sugars intake scale that was developed from the study three. The items were assessing many aspects of beliefs about capabilities to reduce free sugars intakes such as: ability to reduce free sugars intake. Measurements of beliefs about capabilities were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The beliefs about capabilities continuous scale was developed from computing the 16 items

Beliefs about consequences were measured with 61-item beliefs about consequences of reducing free sugars intake scale that was developed from the study three. The items were assessing many aspects of beliefs about consequences to reduce free sugars intakes such as: believe that sugary food leads to tooth decay. Measurements of beliefs about consequences were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The beliefs about consequences continuous scale was developed from computing the 61 items

Social/ professional role and identity was measured with 8-item social or professional role and identity of reducing free sugars intake scale that was developed from the study three. The items were assessing eight aspects of social or professional role and identity to reduce free sugars intakes such as: the influence of professional role in free sugars intake. Measurements of social or professional role and identity were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The social or professional role and identity continuous scale was developed from computing the 8 items

Optimism was measured with 8-item optimism of reducing free sugars intake scale that was developed from the study three. The items were assessing eight aspects of optimism to reduce free sugars intakes such as: confidence of free sugars tax in reducing free sugars intake. Measurements of optimism were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The optimism continuous scale was developed from computing the 8 items

Intentions was measured with 2-item intentions of reducing free sugars intake scale that was developed from the study three. The items were assessing two aspects of

intentions to reduce free sugars intakes, such as, intend to choose sugary food. Measurements of intentions were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The intentions continuous scale was developed from computing the 2 items.

Goals was measured with 2-item goals of reducing free sugars intake scale that was developed from the study three. The items were assessing two aspects of goals to reduce free sugars intakes such as: goal to maintain healthy teeth. Measurements of goals were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The goals continuous scale was developed from computing the 2 items

9.2.8.1.6. Automatic Motivation (three measures)

Reinforcement was measured with 3-item reinforcement of reducing free sugars intake scale that was developed from the study three. The items were assessing three aspects of reinforcement to reduce free sugars intakes such as: colour coding to reinforce the selection of healthy food. Measurements of reinforcement were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The reinforcement continuous scale was developed from computing the 3 items

Social/ Professional role and identity was measured with 4-item social or professional role and identity of reducing free sugars intake scale that was developed from the study three. The items were assessing four aspects of social or professional role and identity to reduce free sugars intakes such as: the influence of annual leave on free sugars intake cariogenic food, colour coding, food labelling. Measurements of social or professional role and identity were in Likert scale of seven and participants were asked to select the appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The social or professional role and identity continuous scale was developed from computing the 4 items

Emotion was measured with 19-item emotion of reducing free sugars intake scale that was developed from the study three. The items were assessing many aspects of emotion to reduce free sugars intakes such as: the love of sugary food. Measurements of emotion were in Likert scale of seven and participants were asked to select the

appropriate option for them for each item. For more details please refer to appendix number 13.10.16 for detailed questions. The emotion continuous scale was developed from computing the 19 items

9.2.9. Process for Recruitment

The process of recruitment for this study was via Internet and email advertisements. The Internet advertisements were carried out on two websites: King's College London research advertisement and Call For Participants website (JISC, 2018). Call For Participants is platform that allows researcher to advertise and share their research with interested participants (JISC, 2018). Participants around the world can access and apply for the research according to their interest and if they fulfil the criteria set by the researchers (JISC, 2018). The two websites could reach potentially to larger participants from King's College London and the advertisements were accessible for 24 hours any time (Chin and Lee, 2008). However, two downsides of using this method of recruitment are missing participants who are not accessing the Internet and the risk of fake participants (Chin and Lee, 2008). The researcher assumed that using snowballing strategy would help minimize the first downside. For the second downside, the researcher assumed blinding interested volunteers from knowing the inclusion criteria of the study and filtering any volunteers from the study who did not meet the criteria using the Qualtrics system would minimize the fake participants. Also, the researcher used IP address verification system to check address claimed by the participants.

Participants were recruited through King's College London and Call for Participant website based on the sample criteria set in the qualitative interviewing the advertisement contained the following information: the purpose of the study, the incentives (to attract participants) and email address of the researcher (SHAR) for further information about the searcher. This method of recruitment allowed recruitment of volunteers without pressure and through informed choice. Initially, the researcher applied for the advertisement for the recruitment of his study at King's College London via Research Ethics Office and Call For Participants via JISC (2018). Then, the advertisement of the study was posted at King's College London recruitment volunteer webpage for a month based on their policy and at Call for Participants webpage for a month set by the researcher. Also, at King's College

London the advertisement was circulated via King's College London global email system, which made the advertisement more accessible to many students and staff at the college. Voluntarily interested participants who read the advertisement on the webpage or email would send an email to the researcher for more information about the study. After receiving the email, the researcher would send information sheet about the study to the interested participants via Qualtrics systems of emails. Any participant who accepted the terms in the information was automatically forwarded to the part of the survey. However, if any participant did not accept the terms in the information sheet, then they were excluded from the study. Participants who voluntarily agreed to take part in the study were sent the consent form section to consent according to terms and if s(he) consent the form, then will continue to the rest of the survey according to their answer as explained in section 9.2.7. Survey Context.

9.2.10. Procedure and Data Collection

Data collection and procedure started after participants accepted terms in the consent form within the online survey as explained in section 9.2.7. Survey Context. The participant, would start with demographic data question, where there are three questions set to exclude participant who do not fulfil 1) the nationality criteria as British 2) ethnicity criteria as White Scottish, English, Welsh, Northern Irish, British Irish, Gypsy or Traveller-in (Office for National Statistics, 2015; P8.) and 3) healthy criteria of being healthy and mental sound. After successful completion of the demographic questions, the participants moved to the sugary food intake section. In this section, participants rated the intake per time of 44 sugary foods and drinks and list any additional sugary food they have including milk and cereals. Next, participants moved to the questions of factor related to reduce free sugars intake based on 14 TDF domains and COM-B model. Afterwards, participants moved to the last section where they entered their email address and submitted the survey. A reminder email via Qualtrics was sent to the interested participants who did not complete the survey. Upon completion of the survey, the participants would receive a £20 e-Amazon gift card via their emails.

After each completion of the survey by a participant, Qualtrics sent email of every survey completed to the researcher and stored within Qualtrics online database. After the targeted sample size of 200 participants was achieved, the researcher closed the

online survey and downloaded the full data set from the Qualtrics online database as SPSS format. During the process of completing the online survey by the participants there was a contamination of 190 samples of scammers out of 390 samples who completed survey. The scammers had a wrong identity as British and White ethnic. The researcher was able to verify the scammers through three factors: the huge amount of emails received as completed survey from Qualtrics in short time and the completed survey would have same IP addresses outside the UK and the fake email with nonsense address. Therefore, after verification of the 190 scammers, the researcher downloaded the dataset as SPSS format file from the Qualtrics platform and had to manually screen and exclude the 190 biased samples from the 390 samples. This would leave the researcher with 200 eligible samples for data analysis and assumed they would be with very minimal chance of contamination.

9.2.11. Data analysis

The SPSS version 24.0. for MacBook was used to conduct all analyses to achieve the study objectives. Two text statistical guide books, Elliott and Woodward (2007) and Field (2013), were used in the analysis of the data. Also, departmental statistician was consulted during the statistical analysis in this study. The researcher used SPSS to screen and exclude the contaminated samples (500 scammers). This process was carried out through benchmarking of the 700 samples in SPSS with 200 emails of eligible samples and then deleted the 500 ineligible samples from SPSS file. After that Data Descriptive univariate analysis was carried out to describe sample characteristics and other outcome measures; this including standard deviations, means medians and ranges. Also, nominal, categorical, and continuous data were summarised using frequencies. The internal consistency of the measuring instrument will be assessed using Cronbach's alpha. Raw data gathered from sugary diet intake section cannot be analysed directly because it does not give the reading of free sugars intake of the participants. Therefore, the researcher had to process the raw data to continue categorising data for purpose of the analysis. An attempt was made to use an available tool (FETA) for FFQ- EPIC that was developed by the authors of the FFQ-EPIC (Mulligan et al, 2013) and can help to process raw data to measure free sugars intake. However, the tool did not work according to the plan, and a mistake happened that prevented the researcher from processing the raw data. Alternatively, the researcher contacted one of the authors (MAA) of the FFQ-EPIC for an assistant to

process the data, the author (MA) agreed to process the data and sent them to the researcher of the current study.

After the researcher received the processed data, he calculated the total free sugars intake of each of the 200 participants using Excel for Mac version 16.14. (continuous data). He also created categorical data for two groups: high (>30g of free sugars intake per day) and low (≥30g of free sugars intake per day) for analysis (SACN, 2015). Body Mass Index continues data and categorical data of each participant was created using highest and weight measurement of each of them. The researcher had to regroup (some cases joint two groups) within each of the following demographic data: ethnicity, employment, age, qualifications, dental history, current health, household, place of living, and BMI. Table 34 presents the original groups after data collection and new groups that were regrouped. This had facilitated the analysis of the categorical data related to the demographic data. For TDF data, a scale was developed for each domain that was used in regression analysis to predict the free sugars intake.

The normality of the data was checked using histogram, box plot, and Shapiro–Wilk and Kolmogorov–Smirnov tests and before carrying out parametric or nonparametric tests to ensure that the data's compliance with the rules of parametric tests (Field 2013). For normally distributed continuous data, the researcher used the following tests: independent samples t test, one-way ANOVA (Bonferroni), and Pearson's correlations. In contrast, for not normally distributed continuous data or ordinal, the researcher used the following tests: Kruskal–Wallis one-way ANOVA, Mann–Whitney U test, and Spearman's rank-order correlation. For categorical data, Chi-square tests were used to assess the association between level of free sugars intake and demographic data. Lastly, multiple logistic regression was applied to examine the prediction of TDF factors on free sugars intake among White ethnic groups in the UK and to assess the prediction of dental filling status on free sugars intake.

Table 34: Original groups after data collection and new groups after regrouping:

Categories	**Original group**	**New groups**
Body Mass Index (BMI)	Underweight (UW)	(UW)

	Health	Health
	Overweight (OW)	(OW)
	Obese One (Ob1)	(Ob)
	Obese Two (Ob2)	
	Obese Three (Ob3)	
White Ethnicity	White English	White British
	White Scottish	
	White Welsh	
	White British	
	White Irish	Other White
	Other White	
Employment status	KCL Staff	KCL Participants
	KCL Students	
	Non-KCL Staff	Non-KCL Participants
	Non-KCL Students	
	Retired	Not working
	Unable to work	
Age	Young adults	
	Middle age adults	
	Old age adults	
Qualifications	A level / relevant Qualifications	A level/ Diploma
	Secondary School / Diploma level	
	Bachelor/ BDS/ relevant Qualifications	Undergraduate
	Masters level (MSc; MDent, MD, etc.)	Postgraduate

	PhD/ relevant Qualifications	
	Others	Others
Dental filling History	Less than a year	Six months–1 year ago
	A year ago	
	Two years ago	2–3 years ago
	Three years ago	
	Four years ago	4 years and more
	More than four years	
Current Health	Excellent	Very Good
	Very good	
	Good	Good
	Fair	Not Good
	Poor	
Household	Owns Outright	Owns or just to own
	Owns with a mortgage	
	Just about to own Outright	
	Pays part rent and Part mortgage	
	Rents from a council	Rent (low income)
	Rents from a housing association	
	Rents from a private landlord	Rent with private
	Accommodation Residential home / student hall	
	Rents from Family	

	Flat share (renting)	
Placing of Living	North East England	North of England
	North West England	
	Yorkshire and the Humber	
	East Midlands	Middle of England
	West Midlands	
	East of England	
	South East England (Excluding London)	South of England
	South West England	
	Greater London	London
	Wales	Rest of the UK
	Scotland	
	Northern Ireland	

9.2.12. Monetary rewards

The participants would receive a £20 e-Amazon gift card via their emails after completion of the survey. The purpose of the incentive is to encourage the participants to contribute to the study and to offer appreciation for their time.

9.3. RESULTS

9.3.1. Response Rate

The researcher ended the recruitment of the current study when the target sample size was reached; table 35 indicate the summary of survey distributions. The researcher received 1661 emails from individulals who were interested in participating in the survey. From these applicants, 793 participants were randomly selected and invited to take part in the survey. Of these, 772 agreed to take part in the survey, resulting in a response rate of 97% (Fink, 2017). The number of participants who completed the

survey was 698, which led to a completion rate of 90%. After the screening and exclusion process, a total of 200 completed surveys were eligible for inclusion in the study, leading to target sample size.

Table 35: Summary distribution of the survey:

Distribution Summary		Total N (%)	
Interested in the survey	Not invited	868 (52)	1661
	Invited	793 (48)	
Invited to the Survey	Not respond	21 (3)	793
	Respond	772 (97)	
Respond to the Survey	Partially completed*	74 (10)	772
	Fully completed	698 (90)	
Fully Completed the Survey	Scammers	190 (27)	698
	Non-scammers	508 (73)	
Completed Non-scammers	Excluded from the analysis**	308 (61)	508
	Included in the analysis	200 (39)	

* Who willingly stopped to complete the survey
** Who did not meet the inclusion criteria

9.3.2. Demographic Characteristics of the samples

The distribution of the demographic characteristics of the 200 participants is given in table 35. The Majority of the participants were White British (96%) from White English, Scottish, Welsh and British background. Also, majority of the participants young adults aged between 18 and 32 (82 %) and more than a half were females (64.5%) and from King's College London (67.5%). Many of the participants were from greater London (63 %) and majority of the participant were from working class: Emergent service workers (22%), and Traditional working class (21.5%), New affluent workers (36%). In terms of Body Mass Index (BMI), majority of the participant were healthy (76%), but many of the participants are high free sugars intakes (67.5%); also, the mean of free sugars intakes is 57 grams per day. In terms of having dental filling, 52.5% of the participants had no dental fillings. See table 36 for a more complete characteristics of the samples.

Table 36: Demographic Characteristics of the Participants:

Demographic Characteristics		N (%)	Mean (SD)	Median (Min, Max)	Total N(%)
Ethnicity	White British	192 (96)	1.04 (0.20)	1.00 (1,2)	200 (100%)
	Others White	8(4)			
Employment	KCL	135(67.5)	1.33 (0.50)	1.00 (1,3)	198 (99%)
	Non-KCL	60(30)			
	Unemployed	3(1.5)			
Age	Young Adults (18-32)	164(82)	1.20 (0.46)	1.00 (1,3)	198 (99%)
	Middle Age Adults (33-52)	29(14.5)			
	Old Age Adults (53-above)	5(2.5)			
Gender	Male	71(35.5)	1.65 (0.48)	2.00 (1,2)	200 (100%)
	Female	129(64.5)			
Qualification	A level or Diploma	75(37.5)	1.89 (0.79)	2.00 (1,3)	200 (100%)
	Undergraduate	73(36.5)			
	Postgraduate	52(26)			
Dental Filling Status	Dental Filling	95(47.5)	1.53 (0.50)	2.00 (1,2)	200 (100%)
	Free from Dental Filling	105(52.5)			
Dental Filling History	One year and less	26(13)	2.11 (0.81)	2.00 (1,3)	95 (47.5%)
	2-3 years ago	33(16.5)			
	4 years and more	36(18)			
BMI	Under Weight (≤ 18.4)	5(2.5)	2.25 (0.61)	2.00 (1,4)	199 (100%)
	Health (18.5- 24.9)	152(76)			
	Over Weight (25-29.9)	29 (14.5)			
	Obese (≥ 30)	13(6.5)			
Current Health Condition	Very Good	135(67.5)	1.42 (0.65)	1.00 (1,3)	200 (100%)
	Good	47(23.5)			
	Not Good	18(9)			
House Hold Status	Owns or just to own a house	118(59)	1.79 (0.96)	1.00 (1,3)	200 (100%)
	Rent from council or housing association	7(3.5)			
	Rent from Private	75(37.5)			
Social Class	Precariat	8(4)	3.73 (1.43)	4.00 (1,6)	200 (100%)
	Emergent service workers	44(22)			

	Traditional working class	43(21.5)			
	New affluent workers	19(9.5)			
	Middle class	72(36)			
	Elite	14(7)			
Place of living	North of England	10(5)	3.45 (0.91)	4.00 (1,5)	200 (100%)
	Middle of England	24(12)			
	South of England	36(18)			
	Greater London and London	126(63)			
	Rest of the UK	4(2)			
Free Sugars intake- levels	Low Free Sugars Intake	65(32.5)	1.68 (0.47)	2.00 (1,2)	200 (100%)
	High free Sugars Intake	135(67.5)			
Free Sugars intake (g)			56.99 (43.40)	45.18 (3.74,232.87)	200(100%)
Height (cm)			171.02 (14.92)	172.25 (56.20,227.40)	200(100%)
Weight (kg)			68.24 (14.14)	66.50 (44.20, 132.70)	200(100%)
BMI			24.06 (11.89)	22.24 (17.30, 174.10)	200(100%)

9.3.3. Descriptive Statistics of Factors related to Reducing Free Sugars Intake Based on Theoretical Domains Framework (TDF)

Knowledge, memory attention, decision processes environment context and resources and beliefs about consequences were the most frequently reported factors that influence the reduction of free sugars intake among the White Ethnic groups from the samples (i.e. Capabilities, Opportunities and Motivation are the main factors to reduce free sugars intake). In Contrast, behaviour regulations, intention, goal, Reinforcement, Social and Professional Role and Identity (Automatic Motivation) were the least frequently reported factors that influence the reduction of free sugars intake among the White Ethnic groups from the samples (i.e. Capabilities and Motivation are the main factors to reduce free sugars intake). See table 37 for more detailed Descriptive Statistics of Factors related to Reducing Free Sugars Intake Based on (TDF).

Tables 37: Descriptive statistics of factors related to reducing free sugars intake based on (TDF):

Total TDF Frequencies	Mean (SD)	Median (Min, Max)	Mode
Knowledge of reducing free sugars intake	117.01 (15.3)	118 (65,157)	130
Psychological skills related to reducing educing free sugars intake	40.57 (8.8)	41 (9,63)	42
Memory Attention, Decision Processes related to reducing free sugarss intake	179.18 (22.9)	180 (113,241)	169[a]
Behaviour Regulations related to reducing free sugarss intake Total Score	5.09 (2.3)	5 (2,14)	3[a]
Physical Skills related to reducing free sugarss intake Total Score	24.88 (4.3)	25 (14,34)	27
Social Influence Related to reducing free sugars	34.58 (9.4)	36 (12,62)	39
Environment Context and Resources related to reducing free sugars	236.62 (24)	235 (162,308)	229
Social and Professional Role and Identity Reflective Motivation Related to reduce free sugars intake	31.24 (8.2)	32 (8,49)	37
Beliefs About Capabilities related to reduce free sugars intake	84.97 (11.6)	83.5 (55,120)	79[a]
Optimism related to reduce free sugars intake	42.69 (7.2)	44 (18,56)	48
Intention related to reduce free sugars intake	6 (2.2)	6 (2,14)	4
Goal related to reduce free sugars intake	11.69 (1.7)	12 (3,14)	12
Reinforcement related to reduce free sugars intake	15.34 (2.6)	15 (7,21)	15
Social and Professional Role and Identity Automatic Motivation related to reduce free sugars intake	16.25 (4.4)	16 (5,27)	16
Emotions related to reduce free sugars intake Total score	84.3 (12.4)	85 (51,117)	85
Beliefs About Consequences related to reduce free sugars intake	294.2 (27.9)	291.5 (218, 375)	280

a. Multiple modes exist. The smallest value is shown

9.3.3. Reliability test

The internal consistency test was carried out using Cronbach's alpha for factors related to reducing free sugars intake based on TDF scales in the survey. Majority of the TDF scales have Cronbach's alpha between excellent at α 0.883 and acceptable at α 0.711. However two of the domains, goal and reinforcement, have questionable Cronbach's alpha scores of $\alpha = 0.614$ and $\alpha = 0.603$, respectively. Behaviour Regulations domains has the lowest Cronbach's alpha score, which is poor at $\alpha = 0.439$ (n.b., caution should be taken when interpreting goal, reinforcement, and Behaviour Regulations). Therefore, findings from goal, reinforcement, Behaviour, and Regulations domains should be treated with caution due to low level of

Cronbach's alpha score. See table 38 for more detailed about Cronbach's alpha of each TDF domains related to reducing free sugars intake.

Table: 38: Cronbach's alpha of each TDF domains related to reducing free sugars intake:

COM-B Components		TDF Domains	No of Items	**Cronbach's Alpha**	Mean (SD)
Capabilities	Psychological	Knowledge	28	0.726	117 (15.3)
		Psychological Skills	10	0.740	63.8 (8.5)
		Memory Attention, Decision Processes	41	0.848	179.2(22.9)
		Behaviour Regulations	2	0.439	5.1 (2.3)
	Physical	Physical Skills	5	0.711	24.9 (4.3)
Opportunities	Social	Social Influences	10	0.767	34.6 (9.4)
	Physical	Environment Context and Resources	50	0.841	236.62 (24)
Motivation	Reflective	Beliefs About Capabilities	16	0.810	85 (11.6)
		Beliefs About Consequences	61	0.883	294.2 (27.9)
		Social and Professional Role and Identity	8	0.778	31.2 (8.2)
		Goal	2	0.614	11.7 (1.7)
		Intention	2	0.827	6 (2.2)
		Optimism	8	0.786	42.7 (7.2)
	Automatic	Social and Professional Role and Identity	4	0.773	16.3 (4.4)
		Reinforcement	3	0.603	15.3 (2.6)
		Emotions	19	0.730	84.4 (12.3)

When combining the scales of the TDF domains to form COM-B elements the Cronbach's alpha score changes. All of the COM-B elements have Cronbach's alpha between excellent at α 0.881 and acceptable at α 0.711. See table 39 for more detailed about Cronbach's alpha of each COM-B elements related to reducing free sugars intake.

Table: 39: Cronbach's alpha of each COM-B elements related to reducing free sugars intake:

COM-B Components							
	Cronbach Alpha	No Items	Mean (SD)		Cronbach Alpha	No Items	Mean (SD)
Capabilities	0.841	86	390.1 (34)	Psychological	0.838	81	366.0(32.9)
				Physical	0.711	5	24.9 (4.3)
Opportunities	0.858	60	271.2(28.7)	Social	0.767	10	34.6 (9.4)
				Physical	0.841	50	236.62 (24)
Motivation	0.881	123	574.5 (41.6)	Reflective	0.863	97	176.7 (16.9)
				Automatic	0.797	26	115.7(15.8)

9.3.4. Differences Between High and low free sugars intake groups

Table 40 demonstrates the statistical differences between high and low free sugars intakes among White ethnic groups in the UK. There were statistical differences between the high and low free sugars intakes among White ethnic groups in the follow TDF domains: knowledge, physical skills, social influence, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role and identity (Automatic), and emotions. However, in some of the previous domains, the high free sugars intake group has high scores which are: knowledge, social influence, environment context and resources, beliefs about consequences, intention, social and professional role and identity (Automatic), and emotions. For instance, there was significant difference in the knowledge domain scores between high free sugars intake group (M=118.91, SD=14.733) and low free sugars intake group (M= 113.05, SD=15.716), and P. Value (0.011). See table 40 for more details.

Table 40: Statistical differences between high and low free sugars intake groups:

COM-B Components		TDF Domains	Statistical Measurements	Free Sugars intake Groups (N)	
				Low Free sugars Intake (65)	High Free sugars Intake (135)
Capabilities	Psychological	**Knowledge**	Mean (SD)	113.05(15.716)	118.91(14.733)
			Median (Min, Max)	115(65,146)	119(81,157)
			P. Value	0.011	
		Psychological Skills	Mean (SD)	40.63(10.283)	40.54(8.046)
			Median (Min, Max)	41(9,63)	41(16,58)
			P. Value	0.951	
		Memory,Attention, Decision Processes	Mean (SD)	178.23(24.079)	179.64(22.419)
			Median (Min, Max)	177(127,241)	181(113,233)
			P. Value	0.686	
		Behaviour Regulations	Mean (SD)	4.95(2.552)	5.16(2.192)
			Median (Min, Max)	5(2,14)	5(2,10)
			P. Value	0.339	
	Physical	**Physical Skills**	Mean (SD)	26.22(4.543)	24.33(4.044)
			Median (Min, Max)	27(14,34)	23(17,34)
			P. Value	0.001	
Opportunities	Social	**Social Influence**	Mean (SD)	32.51(9.026)	35.57(9.439)
			Median (Min, Max)	33(12,57)	38(12,62)
			P. Value	0.030	
	Physical	**Environment Context and Resources**	Mean (SD)	226.49(20.809)	241.50(23.916)
			Median (Min, Max)	227(162,270)	240(178,308)
			P. Value	0.000	
Motivation	Reflective	**Beliefs About Capabilities**	Mean (SD)	87.31(13.150)	83.84(10.628)
			Median (Min, Max)	85(55,120)	82(64,115)
			P. Value	0.048	
		Beliefs About Consequences	Mean (SD)	288.03(24.464)	297.17(29.012)
			Median (Min, Max)	287(218,369)	295(288,375)
			P. Value	0.030	
		Social and Professional Role and Identity (Reflective)	Mean (SD)	30.78(8.270)	31.45(8.220)
			Median (Min, Max)	30(8,49)	33(11,48)
			P. Value	0.592	
		Goal	Mean (SD)	11.91(1.598)	11.58(1.717)
			Median (Min, Max)	12(6,14)	12(3,14)

			P. Value	0.163	
		Intention	Mean (SD)	5(1.714)	6.47(2.272)
			Median (Min, Max)	5(2,13)	6(2,14)
			P. Value	0.000	
		Optimism	Mean (SD)	42.71(7.318)	42.68(7.141)
			Median (Min, Max)	43(18,56)	44(18,54)
			P. Value	0.558	
	Automotive	**Social and Professional Role and Identity (Automatic)**	Mean (SD)	13.45(4.066)	17.06(3.858)
			Median (Min, Max)	13(5,26)	18(8,27)
			P. Value	0.000	
		Reinforcement	Mean (SD)	15.71(2.511)	15.16(2.631)
			Median (Min, Max)	16(7,21)	15(8,21)
			P. Value	0.224	
		Emotions	Mean (SD)	77.57(11.622)	87.53(11.414)
			Median (Min, Max)	88(51,115)	88(51,115)
			P. Value	0.000	

9.3.8. Differences Between Male and female:

Table 41 displays the statistical differences between female and male White ethnic groups in the UK. There were statistical differences between female and male in the following TDF domains: physical skills, beliefs about consequences, and intention. For example, there was a significant difference between female (M=25.35, SD=4.365), and male (M=24.01, SD=4.080) in the physical skills domain with P. Value (0.036). See table 41 for more details.

Table 41: Statistical differences between different gender:

COM-B Components		TDF Domains	Statistical Measurements	Gender	
				Male (71)	Female (129)
Capabilities	Psychological	Knowledge	Mean (SD)	116.15(14.080)	117.47(15.921)
			Median (Min, Max)	118(73,143)	118(65,157)
			P. Value	0.56	
		Psychological Skills	Mean (SD)	40.68(7.632)	40.50(9.422)
			Median (Min, Max)	39(26,61)	42(9,63)
			P. Value	0.900	
			Mean (SD)	177.06(23.149)	180.35(22.799)

		Memory Attention, Decision Processes	Median (Min, Max)	177(113,231)	181(113,241)
			P. Value	0.332	
		Behaviour Regulations	Mean (SD)	4.76(2.233)	5.27(2.341)
			Median (Min, Max)	5(2,10)	5(2,14)
			P. Value	0.188	
	Physical	Physical Skills	Mean (SD)	24.01(4.080)	25.35(4.365)
			Median (Min, Max)	23(17,34)	26(14,34)
			P. Value	0.036	
Opportunities	Social	Social Influence	Mean (SD)	35.93(9.528)	33.83(9.274)
			Median (Min, Max)	38(14,59)	35(12,62)
			P. Value	0.131	
	Physical	Environment Context and Resources	Mean (SD)	238.44(25.835)	235.62(22.904)
			Median (Min, Max)	238(162,290)	234(177,308)
			P. Value	0.426	
Motivation	Reflective	Beliefs About Capabilities	Mean (SD)	85.27(11.165)	84.81(11.857)
			Median (Min, Max)	81(66,120)	84(55,119)
			P. Value	0.788	
		Beliefs About Consequences	Mean (SD)	300.07(28.860)	290.97(26.905)
			Median (Min, Max)	296(228,366)	290(218,375)
			P. Value	0.027	
		Social and Professional Role and Identity (Reflective)	Mean (SD)	30.49(8.640)	31.64(7.986)
			Median (Min, Max)	31(13,47)	33(8,49)
			P. Value	0.413	
		Goal	Mean (SD)	11.59(1.761)	11.74(1.642)
			Median (Min, Max)	12(3,14)	12(4,14)
			P. Value	0.648	
		Intention	Mean (SD)	6.52(2.286)	5.71(2.126)
			Median (Min, Max)	6(2,13)	5(2,14)
			P. Value	0.005	
		Optimism	Mean (SD)	43.66(6.410)	42.16(7.542)
			Median (Min, Max)	44(18,54)	43(18,56)
			P. Value	0.179	
	Automatic	Social and Professional Role and Identity (Automatic)	Mean (SD)	16.73(4.557)	15.98(4.266)
			Median (Min, Max)	17(7,25)	16(5,27)
			P. Value	0.248	
		Reinforcement	Mean (SD)	14.87(2.408)	15.59(2.674)
			Median (Min, Max)	15(8,21)	16(7,21)

			P. Value	0.062	
		Emotions	Mean (SD)	84.98(13.188)	83.98(11.940)
			Median (Min, Max)	85(51,115)	84(51,117)
			P. Value	0.625	

9.3.9. Differences Between different Qualifications:

Table 42 presents the statistical differences between different levels of education among White ethnic groups in the UK. There were overall statistical differences between A level or diploma, undergraduate, and postgraduate levels among the White ethnic groups in the follow TDF domains: knowledge, physical skills, social influence, environment context and resources, beliefs about capabilities, beliefs about consequences, social and professional role and identity (automatic motivation), intention, and emotion. Further, according to one-way ANOVA test, there were also significant differences between two levels of education, these differences various among TDF domains. For instance, there was significant difference ($P = 0.029$) in the knowledge domain between A level or diploma (M=120.69, SD=12.714), undergraduate (M=115.05, SD=14.667) and postgraduate (M= 114, SD=18.422). However, with the physical skills domain, there were significant differences between both three levels and two levels of education. There were significant differences ($P = 0.029$) between A level or diploma (M=23.16, SD=3.369), undergraduate (M=26.40, SD=4.515), and postgraduate (M=25.21, SD=4.390). Furthermore, the significance was $P = 0.000$ between the A level or diploma and undergraduate level and $P = 0.010$ between A level or diploma and postgraduate levels. See Table 42 for more details.

Table 42: Statistical differences between three levels of education:

COM-B Components		TDF Domains	Statistical Measurements	Qualification		
				A level or Diploma (75)	Undergraduate (73)	Postgraduate (52)
Capabilities	Psychological	Knowledge	Mean (SD)	120.69(12.714)	115.05(14.667)	114(18.422)
			Median (Min, Max)	119(84,151)	115(81,143)	118.50(65,157)
			P. Value	0.029*		
			Mean (SD)	40.33(8.098)	41.64(8,577)	39.40(10.034)

		Psychological Skills	Median (Min, Max)	39(16,57)	42(23,63)	42(9,56)
			P. Value	0.361		
		Memory Attention, Decision Processes	Mean (SD)	183.96(19.805)	175.77(24.290)	177.08(24.350)
			Median (Min, Max)	184(147,233)	178(113,241)	177.50(113,214)
			P. Value	0.069		
		Behaviour Regulations	Mean (SD)	5.12(2.254)	5.15(2.413)	4.96(2.283)
			Median (Min, Max)	5(2,10)	5(2,14)	5(2,12)
			P. Value	0.868		
	Physical	Physical Skills	Mean (SD)	23.16(3.369)	26.40(4.515)	25.21(4.390)
			Median (Min, Max)	22(18,34)	27(17,34)	26(14,32)
			P. Value	0.000*	0.000(AL&UG)	0.010(AL&PG)
Opportunities	Social	Social Influence	Mean (SD)	37.65(9.261)	34.18(8.948)	30.69(8.797)
			Median (Min, Max)	39(12,62)	35(12,57)	30.50(14,52)
			P. Value	0.000*		0.000(Al&PG)
	Physical	Environment Context and Resources	Mean (SD)	249.21(22.509)	232.16(19.305)	224.71(23.924)
			Median (Min, Max)	246(198,308)	231(180,296)	225(162,281)
			P. Value	0.000*	0.000(AL&UG)	0.000(AL&PG)
Motivation	Reflective	Beliefs About Capabilities	Mean (SD)	82.25(10.172)	87.21(12)	85.75(12.332)
			Median (Min, Max)	79(65,115)	86(64,120)	85.50(55,111)
			P. Value	0.028*		0.027(AL&UG)
		Beliefs About Consequences	Mean (SD)	307.17(28.910)	287.32(21.908)	285.15(27.300)
			Median (Min, Max)	303(239,375)	286(233,334)	285(218,369)
			P. Value	0.000*	0.000(AL&UG)	0.000(AL&PG)
		Social and Professional Role and Identity (Reflective)	Mean (SD)	32.23(8.793)	30.66(7.835)	30.62(7.909)
			Median (Min, Max)	34(11,48)	31(15,46)	30.50(8,49)
			P. Value	0.420		
		Goal	Mean (SD)	11.53(1.826)	11.71(1.467)	11.87(1.760)
			Median (Min, Max)	12(3,14)	12(6,14)	12(6,14)
			P. Value	0.494		
		Intention	Mean (SD)	7.20(2.296)	5.56(1.986)	4.87(1.482)
			Median (Min, Max)	7(4,14)	5(2,13)	4.50(2,9)
			P. Value	0.000*	0.000(AL&UG)	0.000(AL&PG)

		Optimism	Mean (SD)	43.01(6.246)	42.56(7.474)	42.40(8.091)
			Median (Min, Max)	44(18,53)	44(19,56)	44(18,56)
			P. Value	0.983		
	Automatic	Social and Professional Role and Identity (Automatic)	Mean (SD)	18.51(3.342)	15.30(4.172)	14.33(4.622)
			Median (Min, Max)	18(10,27)	15(7,26)	14(5,24)
			P. Value	0.000*	0.000(AL&UG)	0.000(AL&PG)
		Reinforcement	Mean (SD)	14.92(2.448)	15.62(2.580)	15.54(2.804)
			Median (Min, Max)	15(8,21)	15(9,21)	16(7,21)
			P. Value	0.214		
		Emotions	Mean (SD)	90.04(10.472)	81.97(12.013)	79.27(12.343)
			Median (Min, Max)	91(59,115)	82(51,117)	79(51,112)
			P. Value	0.000*	0.000(AL&UG)	0.000(AL&PG)

9.3.10. Differences Between different Dental filling status:

Table 43 displays the statistical differences between participants with dental filling and without dental filling among the White ethnic groups in the UK. There were statistical differences between female and male in the following TDF domains: social influence, intention, social and professional role and identity (Automatic motivation), and emotions. For example, there was a significant difference between White ethnic with dental filling (M=32.56, SD=9.330) and without dental filling (M=36.40, SD=9.117) in the social influence domain with *P*. Value (0.004). See table 43 for more details.

Table 43: Statistical differences between participants with dental filling and without dental filling:

COM-B Components		TDF Domains	Statistical Measurements	Dental Filling Status	
				Dental Filling (95)	Free from Dental Filling (105)
Capabilities	Psychological	Knowledge	Mean (SD)	117.82(16.961)	116.27(13.602)
			Median (Min, Max)	119(65,151)	118(81,157)
			P. Value	0.478	

		Psychological Skills	Mean (SD)	40.36(9.2414)	40.76(8.265)
			Median (Min, Max)	42(9,57)	41(16,63)
			P. Value	0.747	
		Memory Attention, Decision Processes	Mean (SD)	177.11(23.445)	181.06(22.381)
			Median (Min, Max)	180(113,217)	180(127,241)
			P. Value	0.224	
		Behaviour Regulations	Mean (SD)	4.94(2.088)	5.23(2.497)
			Median (Min, Max)	5(2,12)	5(2,14)
			P. Value	0.583	
	Physical	Physical Skills	Mean (SD)	25.11(4.124)	24.67(4.469)
			Median (Min, Max)	26(14,34)	24(17,34)
			P. Value	0.473	
Opportunities	Social	Social Influence	Mean (SD)	32.56(9.330)	36.40(9.117)
			Median (Min, Max)	33(12,62)	39(12,59)
			P. Value	0.004	
	Physical	Environment Context and Resources	Mean (SD)	233.64(22.831)	239.31(24.736)
			Median (Min, Max)	233(162,296)	236(177,308)
			P. Value	0.095	
Motivation	Reflective	Beliefs About Capabilities	Mean (SD)	85(11.243)	84.94(11.948)
			Median (Min, Max)	84(55,115)	81(64,120)
			P. Value	0.972	
		Beliefs About Consequences	Mean (SD)	290.17(25.291)	297.85(29.692
			Median (Min, Max)	292(218,369)	290(233,375)
			P. Value	0.052	
		Social and Professional Role and Identity (Reflective)	Mean (SD)	31.68(7.947)	30.83(8.479)
			Median (Min, Max)	33(8,49)	31(11,48)
			P. Value	0.464	
		Goal	Mean (SD)	11.86(1.711)	11.52(1.647)
			Median (Min, Max)	12(4,14)	12(3,14)
			P. Value	0.133	
		Intention	Mean (SD)	5.57(2.092)	6.38(2.259)
			Median (Min, Max)	5(2,14)	6(2,14)
			P. Value	0.006	
		Optimism	Mean (SD)	43.23(7.099)	42.20(7.253)

			Median (Min, Max)	44(18,56)	43(18,55)
			P. Value	0.281	
	Automatic	Social and Professional Role and Identity (Automatic)	Mean (SD)	15.53(4.484)	16.90(4.189)
			Median (Min, Max)	16(5,27)	17(7,26)
			P. Value	0.026	
		Reinforcement	Mean (SD)	15.71(2.724)	15(2.446)
			Median (Min, Max)	16(7,21)	15(8,21)
			P. Value	0.055	
		Emotions	Mean (SD)	82.01(12.324)	86.36(12.104)
			Median (Min, Max)	83(51,115)	87(51,117)
			P. Value	0.013	

9.3.11. Differences Between different Dental Filling History:

Table 44 exhibits the statistical differences between three periods of dental filling history among White ethnic groups in the UK. There were overall statistical differences between One year and less, 2-3 years ago, and 4 years and more of having dental filling among the White ethnic groups in the follow TDF domains: psychological skills, physical skills, social influence, beliefs about consequences, and reinforcement. Further, according to one-way ANOVA test, there were also significant differences between two periods of dental filling history, these differences various among TDF domains. For instance, there was significant difference in the psychological skills domain scores between One year and less (M=43.88, SD=7.665), 2-3 years (M=40.21, SD=10.597), and 4 years and more (M=37.94, SD=8.838), with *P*. Value (0.048) and between One year and less and 4 years and more the significance is *P*. Value =0.042. See table 44 for more details.

Table 44: Statistical differences between dental history periods:

COM-B Components		TDF Domains	Statistical Measurements	Dental Filling History (N)		
				One year and less (26)	2-3 years (33)	4 years and more (36)
Capabilities	Psychological	Knowledge	Mean (SD)	122.35(14.533)	118.67(16.894)	113.78(18.113)
			Median (Min, Max)	120.50(98,144)	123(65,151)	113.50(73,142)
			P. Value	0.216		
			Mean (SD)	43.88(7.665)	40.21(10.597)	37.94(8.838)

		Psychological Skills	Median (Min, Max)	46(23,56)	43(9,57)	38.50(19,55)
			P. Value	0.048*		0.042(1&4)
		Memory Attention, Decision Processes	Mean (SD)	176.27(20.252)	184(22.243)	171.39(25.535)
			Median (Min, Max)	176130,212)	190(135,217)	174.50(113,214)
			P. Value	0.086		
		Behaviour Regulations	Mean (SD)	4.62(1.745)	5.52(2.333)	4.64(2.016)
			Median (Min, Max)	4.50(2,11)	6(2,12)	5(2,9)
			P. Value	0.122		
	Physical	Physical Skills	Mean (SD)	27.27(3.106)	24.12(3.352)	24.44(4.866)
			Median (Min, Max)	27.50(20,34)	23(19,32)	25(14,33)
			P. Value	0.006*	0.009(1&2)	0.020(1&4)
Opportunities	Social	Social Influence	Mean (SD)	36.08(8.513)	32.42(9.467)	30.14(9.212)
			Median (Min, Max)	36(16,62)	34(12,57)	30(14,52)
			P. Value	0.045*		0.039(1&4)
	Physical	Environment Context and Resources	Mean (SD)	237.92(20.813)	235.03(21.143)	229.28(25.431)
			Median (Min, Max)	233.50(210,286)	234(178,283)	232(162,296)
			P. Value	0.312		
Motivation	Reflective	Beliefs About Capabilities	Mean (SD)	87.38(9.646)	83.97(12.228)	84.22(11.422)
			Median (Min, Max)	87.50(69,107)	85(55,115)	82.50(58,111)
			P. Value	0.450		
		Beliefs About Consequences	Mean (SD)	301.42(23.590)	290.12(26.646)	282.08(22.582)
			Median (Min, Max)	299.50(265,369)	297(218,334)	283(235,331)
			P. Value	0.011*		0.008(1&4)
		Social and Professional Role and Identity (Reflective)	Mean (SD)	31.92(9.545)	32.09(8.483)	31.14(6.184)
			Median (Min, Max)	33(15,49)	33(8,47)	32.50(18,45)
			P. Value	0.872		
		Goal	Mean (SD)	11.92(1.164)	11.76(2.047)	11.92(1.746)
			Median (Min, Max)	12(9,14)	12(4,14)	12(6,14)
			P. Value	0.915		
		Intention	Mean (SD)	5.54(2.064)	5.70(2.365)	5.47(1.890)
			Median (Min, Max)	5(3,13)	5(2,14)	5(2,10)
			P. Value	0.932		

		Optimism	Mean (SD)	45.19(5.329)	43.45(7.653)	42.61(7.477)
			Median (Min, Max)	46(33,56)	44(18,53)	43(25,56)
			P. Value	0.157		
	Automatic	Social and Professional Role and Identity (Automatic)	Mean (SD)	15.35(4.560)	16.58(5.031)	14.69(3.771)
			Median (Min, Max)	15.50(5,24)	17(7,27)	14(8,21)
			P. Value	0.215		
		Reinforcement	Mean (SD)	16.58(1963)	16.03(3.321)	14.78(2.356)
			Median (Min, Max)	17(12,20)	17(7,21)	15(10,20)
			P. Value	0.005*	0.012(1&4)	0.020(2&4)
		Emotions	Mean (SD)	79.58(10.981)	85.51(13.442)	80.89(11.899)
			Median (Min, Max)	81(51,108)	85(51,115)	80.50(11.899)
			P. Value	0.179		

9.3.15. Association between Free Sugars Intake and demographic data:

A chi-square test was performed to test the hypothesis of association between the levels of free sugars intake and demographic data. Table 45 demonstrates the association between the levels of free sugars intake and demographic data. There were no significant association between the levels of free sugars intake and the following demographic data: ethnicity, employment, age, gender, Dental Filling Status, Dental Filling History, BMI, Current Health Condition, social classes and districts of living. However, there were significant association between the levels of free sugars intake and the following demographic data: qualifications and house hold status. For the qualifications, the association was found X^2 (2, N=200) =12.62, $p< 0.00$. Examining of the cell frequencies presented in the table 50 about 81% (61 out of 75) of the A level or diploma qualification holders were high intake of free sugars while the percentage of high free sugars intakes in all of the other qualification categories was less than 70%. For the household status, the association was found X^2 (2, N=200) =7.17, $p< 0.03$. Examining of the cell frequencies presented in the table 50 about 75% (88 out of 118) of individuals who owns or just to own a house were high intake of free sugars and similar proportion was found with individuals who rent from council or housing association. However, the percentage of high free sugars intakes with

individuals who rent from private sector category was less than 60%. See table 45 for more details.

Table 45: Association between free sugars Intakes and demographics data:

Demographic Groups (N)		Free Sugars Intake N (%)		Significance
		Low Sugars Intake 65(33)	High Sugars Intake 135(67)	X^2 (*p-Value)*
Ethnicity	White British (192)	64 (33)	128 (67)	1.52 (0.44)
	Others White (8)	1(13)	7(87)	
Employment	KCL (135)	48 (36)	87 (64)	1.50(0.47)
	Non-KCL (60)	16 (27)	44 (73)	
	Unemployed (3)	1 (33)	2(67)	
Age	Young Adults (164)	49 (30)	115 (70)	4.00(0.14)
	Middle Age Adults (29)	14 (48)	15 (52)	
	Old Age Adults (5)	1(20)	4 (80)	
Gender	Male (71)	22 (31)	49 (69)	0.12(0.73)
	Female (129)	23 (33)	86 (67)	
Qualifications	A level or Diploma (75)	14 (19)	61 (81)	12.62 (0.00)
	Undergraduate (73)	26(36)	47 (64)	
	Postgraduate (52)	25 (48)	27 (52)	
Dental Filling Status	Dental Filling (95)	36 (38)	59 (62)	2.40(0.13)
	No Dental Filling (105)	29 (28)	76 (72)	
Dental Filling History	One year and less (26)	13 (50)	13 (50)	3.21(0.20)
	2-3 years ago (33)	9 (27)	24 (73)	
	4 years and more (36)	14 (39)	22 (61)	
BMI	Under Weight (5)	0 (0)	5 (100)	4.23(0.24)
	Health (152)	51 (34)	101 (66)	
	Over Weight (29)	9 (31)	20 (69)	
	Obese (13)	5 (39)	8 (61)	
Current Health Condition	Very Good (135)	46 (34)	89 (66)	1.03(0.60)
	Good (47)	15 (32)	32 (68)	
	Not Good (18)	4 (22)	14 (78)	
House Hold Status	Owns or just to own a house (118)	30 (25)	88 (75)	7.17(0.03)
	Rent from council or housing association (7)	2(29)	5 (71)	

	Rent from Private (75)	33 (44)	42 (56)	
Social Class	Precariat (8)	2 (25)	6 (75)	8.52(0.13)
	Emergent service workers (44)	19 (43)	25 (57)	
	Traditional working class (43)	7 (16)	36 (84)	
	New affluent workers (19)	7 (37)	12 (63)	
	Middle class (72)	24 (33)	48 (67)	
	Elite (14)	6 (43)	8 (57)	
Place of living	North of England (10)	2 (20)	8 (80)	3.65(0.46)
	Middle of England (24)	8 (33)	16 (67)	
	South of England (36)	8 (22)	28 (78)	
	Greater London and London (126)	46 (37)	80 (63)	
	Rest of the UK (4)	1 (25)	3 (75)	

9.3.16. Correlation between the TDF Factors to Reduce Free Sugars intake and free sugars intake

An evaluation of the linear relationship between the TDF factors to reduce free sugars intake and free sugars intake and free sugars intake was measured using Pearson's correlation for normally distributed data and Spearman's correlation for not normally distributed data. Table 46 presents the correlation between the TDF Factors to reduce free sugars intake and free sugars intake mapped with COM-B model. There were significant correlations between the following TDF factors and free sugars intake: knowledge, psychological skills, memory attention and decision processes, physical skills, social influences, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role, and identity (automatic motivation) and emotions. However, these correlations varied between negative and positive relationships. For example, there was a significant positive but weak correlation between knowledge factor (domain) and the intake of free sugars r=0.15, n=200, P= 0.036. Unlike with environment were context and resources (r=0.52, P=0.000), intention (r=0.50, P=0.000), social and professional role and identity (automatic motivation) (r=0.51, P=0.000) and emotions (r=0.50, P=0.000) factors (domains) the correlation with free sugars intake was moderately positive. See table 46 for more details and appendix 13.10.07 for plot graphs.

Table 46: Correlation between the TDF Factors to reduce free Sugars Intake and free sugars intake:

COM-B Components		TDF Domains	Significance	Correlation coefficient tests
			r (*P*)	
Capabilities		Knowledge	0.15 (0.036)	Pearson's r
		Psychological Skills	-0.15(0.037)	Pearson's r
		Memory Attention, Decision Processes	0.17(0.019)	Pearson's r
	Psychological	Behaviour Regulation	-0.06(0.420)	Spearman's r
	Physical	Physical Skills	-0.13(0.000)	Spearman's r
Opportunities	Social	Social Influences	0.25 (0.000)	Spearman's r
	Physical	Environment Context and Resources	0.52(0.000)	Pearson's r
Motivation		Beliefs About Capabilities	-0.22(0.002)	Spearman's r
		Beliefs About Consequences	0.30(0.000)	Spearman's r
		Social and Professional Role and Identity	0.03 (0.656)	Spearman's r
		Goal	-0.05(0.516)	Spearman's r
		Intention	0.50 (0.000)	Spearman's r
	Reflective	Optimism	0.28(0.694)	Spearman's r
		Social and Professional Role and Identity	0.51(0.000)	Pearson's r
		Reinforcement	-0.08(0.278)	Spearman's r
	Automatic	Emotions	0.50 (0.000)	Pearson's r

9.3.17. TDF Prediction on Free Sugars Intake

An evaluation of the predictability of the TDF factors related to reduce free sugars intake on free sugars intake was measured using multiple linear regression stepwise method, which removed any variable that don't have significant prediction on free sugars intake. The assessments were carried out different ways: overall prediction, prediction based on the comparison between gender and comparison between the

status of dental filling. Also, assessment was carried out on the predictability of dental filling status on free sugars intake using multiple linear regression stepwise method.

9.3.17.1 TDF Prediction on Free Sugars Intake Overall

A multiple linear regression stepwise method was analysed to predict White ethnic British participants' free sugars intakes based on their rating of theoretical domains framework (TDF) factors to reduce free sugars intake. The regression identified model six significant predictors for free sugars intake with an R^2 of 0.49 and F of 31.182, and $p < .001$. The six predictors are: Environment Context and Resources; Social and Professional Role and Identity (Automatic Motivation); Social and Professional Role and Identity (Reflective Motivation); Reinforcement; Beliefs About Consequences; and Beliefs About Capabilities. The predictability between these predictors various, for instance, environment context and resources positively predicted free sugars intake equal to +0.47, unlike Reinforcement which negatively predicted free sugars intake equal to -3.79. for more details see table 47 which demonstrates the multiple linear regression model 6 of TDF predictors for free sugarss intake among White ethnic groups in the UK.

Table 47: Multiple linear regression model 6 of TDF predictors for free sugars intake (stepwise method):

TDF Predictor	Effect	95.0% Confidence Interval for the effect	P-Value	F- Value	Model 6	
					R Square	Adjusted R Square
Environment Context and Resources	0.47	0.21 to 0.72	0.00	31.20	0.49	0.48
Social and Professional Role and Identity (AM)	3.28	2.08 to 4.48	0.00			
Social and Professional Role and Identity (RM)	-0.98	-1.55 to -0.44	0.00			
Reinforcement	-3.79	-05.63 to -1.94	0.00			
Beliefs About Consequences	0.38	0.17 to 0.59	0.00			

Beliefs About Capabilities	-0.41	-0.80 -0.02	0.04			

AM= Automatic Motivation ; RM= Reflective Motivation

Table 48 demonstrates the linear regression of each of six of TDF predictors for free sugars intake which were identified after the stage of stepwise regression to know the R square. Most of the predictors were statically significant except Social and Professional Role and Identity (RM) predictor was not significant *P=0.08*. The highest R square is of environment context and resources, social and professional role and Identity (AM), and beliefs about consequences respectively. For more details see table 48.

Table 48: Linear regression of the six of TDF predictors for free sugars intake:

TDF Predictor	Effect	95.0% Confidence Interval for the effect	P-Value	F- Value	*R* Square	Adjusted R Square
Environment Context and Resources	0.94	0.72 to 1.16	0.00	72.64	0.27	0.27
Social and Professional Role and Identity (AM)	5.07	3.87 to 6.26	0.00	69.92	0.26	0.26
Social and Professional Role and Identity (RM)	-0.65	-1.38 to 0.84	0.08	3.04	0.02	0.01
Reinforcement	-2.39	-4.71 to -0.07	0.04	4.14	0.02	0.02
Beliefs About Consequences	0.71	0.51 to 0.90	0.00	51.57	0.21	0.20
Beliefs About Capabilities	-0.81	-1.32 to -0.30	0.00	9.78	0.05	0.04

AM= Automatic Motivation ; RM= Reflective Motivation

9.3.17.2 TDF Prediction on Free Sugars Intake Based on Dental Filling Status Grouping

TDF prediction on free sugars intake among White ethnic groups was carried out using a multiple linear regression stepwise method based on the comparison between the dental filling status groups. The regression identified model three, with three

significant predictors for free sugars intake with an R^2 of 0.37 and F of 18.05, and $p <$ 0.001 among White ethnic participants who have dental fillings. The three predictors are: social and professional role and identity (Automatic Motivation), Environment context and resources and physical skills. The predictability between these predictors various, for instance, environment context and resources positively predicted free sugars intake equal to +0.36, unlike physical skills which negatively predicted free sugars intake equal to -1.60. In contrast, for participants without dental fillings, the regression identified model six with four significant predictors for free sugars intake and an $R^2 = 0.53$ and $F = 27.80$, and $p < 0.001$. The four predictors are Social and Professional Role and Identity (Automatic Motivation), Reinforcement, Beliefs About Consequences, and Social and Professional Role and Identity (Reflective Motivation). The predictability between these predictors varies, for instance, social and professional role and identity (Automatic Motivation) positively predicted free sugars intake equal to +4.14, unlike reinforcement which negatively predicted free sugars intake equal to -5.27. For more details see Table 49 which demonstrates the multiple linear regression models 3 and 6 of TDF predictors for free sugars intake based on dental filling status.

Table 49: Multiple linear regression of model 3 and 6 of TDF predictors for free sugars intake based on dental filling status (stepwise method):

Dental Filling status	TDF Predictor s	Effect	95.0% Confidence Interval for effect	P-Value	F-Value	Model	
						R Square	Adjusted R Square
Have Dental Filling (Model 3)	Social and Professional Role and Identity (AM)	2.58	1.41 to 3.73	0.00	18.05	0.37	0.35
	Environment Context and Resources	0.36	0.13 to 0.59	0.00			
	Physical skills	-1.60	-2.79 to -0.40	0.00			
Do not Have Dental Filling (Model 6)	Social and Professional Role and Identity (AM)	4.14	2.26 to 6.02	0.00	27.80	0.53	0.51
	Reinforcement	-5.27	-8.24 to -2.30	0.00			
	Beliefs About Consequences	0.76	0.49 to 1.03	0.00			

	Social and Professional Role and Identity (RM)	-1	-1.89 to -0.11	0.03			

AM= Automatic Motivation ; RM= Reflective Motivation

9.3.17.3 TDF Prediction on Free Sugars Intake Based on Gender grouping

TDF prediction on free sugars intake among White ethnic groups was carried out using a multiple linear regression stepwise method based on the comparison between male and female. The regression identified model four with four significant predictors for free sugars intake with an R^2 of 0.55 and F of 20.31, and $p < .001$ among White ethnic male participants. The four predictors are: environment context and resources; social and professional role and identity (automatic motivation); social and professional role and identity (reflective motivation), and knowledge. The predictability between these predictors various, for instance, environment context and resources positively predicted free sugars intake equal to +0.49, unlike social and professional role and identity (automatic motivation) which positively predicted free sugars intake equal to +5.19. In contrary, with female, the regression-identified model five with five significant predictors for free sugars intake with an R^2 of 0.40 and F of 19.09, and $p < .001$. The five predictors are environment context and resources; social and professional role and identity (automatic motivation); reinforcement; beliefs about consequences and physical skills. The predictability between these predictors various, for instance, social and professional role and identity (Automatic Motivation) positively predicted free sugars intake equal to +2.10, unlike Reinforcement which negatively predicted free sugars intake equal to -3.28. For more details see table 50 which demonstrates the multiple linear regression model 4 and 5 of TDF predictors for free sugars intake based on gender.

Table 50: Multiple linear regression model 4 and 5 of TDF predictors for free sugars intake based on gender (stepwise method):

Gender	TDF Predictor s	Effect	95.0% Confidence Interval for effect	P-Value	F- value	Model	
						R Square	Adjusted R Square
	Environment Context and Resources	0.49	0.05 to 0.93	0.03			

Male (Model 4)	Social and Professional Role and Identity (AM)	5.19	2.82 to 7.56	0.00	20.31	0.55	0.53
	Social and Professional Role and Identity (RM)	-2.10	-3.18 to -1.01	0.00			
	Knowledge	0.68	0.02 to 1.35	0.05			
Female (Model 5)	Environment Context and Resources	0.41	0.12 to 0.70	0.00	19.09	0.40	0.38
	Social and Professional Role and Identity (AM)	2.10	0.79 to 3.40	0.00			
	Reinforcement	-3.28	-5.42 to -1.15	0.00			
	Beliefs About Consequences	0.32	0.08 to 0.56	0.00			
	Physical skills	-1.31	-2.56 to -0.06	0.04			

9.3.18. Dental Filling Prediction on Free Sugars Intake

A multiple linear regression stepwise method was analysed to predict White ethnic British participants' free sugars intakes based on their dental filling status. The regression identified not having dental filling was significant predicting s for free sugars intake with an R^2 of 0.05 and F of 10.63, and $p < .001$. Not having dental filling positively predicted free sugars intake equal to +19.56. For more details see Table 51, which demonstrates the multiple linear regression of dental filling prediction for free sugars intake among White ethnic groups in the UK.

Table 51: Multiple linear regression of dental filling status prediction for free sugars intake (stepwise method):

Dental filling Predictor	Effect	95.0% Confidence Interval for effect	P-Value	F-Value	Model	
					R Square	Adjusted R Square
Not Having Dental Filling	19.56	7.73 to 31.40	0.00	10.63	0.05	0.05

9.3. DISCUSSION:

The current study set out for four aims: to assess the differences between high, low free sugars intake and groups in the demographic data in the TDF domains of reducing free sugars intakes; to examine the association between the two levels of free sugars intake and the demographic groups among White ethnic groups in the UK; to test the correlation between free sugars intake and the TDF domains of reducing free sugars intake; and to assess the predictability of TDF domains for reducing free sugars intake and dental filling toward free sugars intake data among White ethnic adults in the UK. To the knowledge of the researcher, which is based on the literature, the current study was the first to use the COM-B model and TDF to understand and predict free sugars intake among White ethnic adults in the UK. In this section of chapter nine, the researcher discusses the key findings of the current work in relation to each aim.

9.3.1. The Application of the survey

The use of the survey had many benefits for this study that was reported in other literature as discussed previously. The sample size of the respondents is higher in the survey compared with the qualitative study that minimize the errors. Also, the survey achieved larger sample size in short time. Moreover, the online survey allowed the respondents to complete the questionnaire in much convenient way than in the interviews. The survey had three main sections of measurement: demographic data, free sugars intake and TDF domains related to reduce free sugars intake. Piloting the survey was very useful in improving the validity and reliability of the content of the survey. For example, the use of the BBC social class calculator was added after the pilot, the facilitated easy method for the researcher to identify the social classes without any difficulties; also, none of the respondents gave a negative feedback. Also, the use of blending method for nationality and ethnicity was developed through comments from the respondents and other colleagues. Qualtrics auto-set did the filtering of the inclusion criteria related to nationality and ethnicity. thereby minimising the bias selection of the samples and maximising the reliability of the questionnaire. This procedure was found in the internal consistency values that were tested using the Cronbach's alpha of the 200 participants who completed the questionnaire in particular TDF domains section. In the questionnaire, there were 16 TDF domains, 13 of them had interval consist values between acceptable and good,

two domains were questionable, and only one domain was a behaviour regulation domain. Because the survey was not developed as a clinical tool, the researcher accepted the internal consistency value from 0.6; however, he treated below then this value with causation because the value is poor. The finding suggested that majority of the included items and questions in the analysis were reliable and valid.

9.3.2. Response rate

Although the questionnaire was long, the response rate for this study was 97%, which is a high rate (Fink, 2017) that is higher than response rates of other online surveys (Nulty, 2008). There are many possible factors contributed to the high response rate in this study. One of the major **factors** that contributed to the high repose rate was providing incentives (Edwards et al, 2009; Fink, 2017) in particular high incentives (Pit, Vo, and Pyakurel, 2014) to the respondents after compilation the questionnaire. The current study gave £20 E-Amazon voucher for any respondents who completed the survey. Also, the means of claiming the incentives were guaranteed, easy and quick from amazon; around 4.8m households have account with Amazon in the first quitter of 2018 (Barb, 2018). In addition to the above **factor**, the understandability of the questions by the respondents in the survey contributed to high response rate (Fink, 2017). This understandability was achieved from the qualitative interviewing study (Al Rawahi, Asimakopoulou, and Newton, 2018) and pilot study. Another **factor** was the topic of reducing free sugars intake is interesting topic for many adults, because the topic is the current interesting topic for scientists and media (e.g. BBC, sky news,) coverage of the topic made people aware of the important of reducing free sugars intake. Also, the researcher received some comments from respondents or their interest in the topic, which played a role in increasing response rate (Edwards et al, 2009; Fink, 2017). The other factors that contributed to high response rate were sending reminders to the respondents to complete their survey and eligible criteria set for the study including age (Fink, 2017).

9.3.3. Free sugars Intake in Relation to the Demographic data

The demographic data in this current study have shown the diversity of the respondents in many characteristics including ethnicity, age, gender, qualification, and social class. This diversity has enriched the findings, which helped the researcher to achieve the aims. Also, the measurement of the free sugars intake in this study was

reported in grams, which goes along with WHO (2015) recommendation to focus on intake in grams not as frequency. Also, the evidence on the impact frequency intake of free sugars is very limited and more studies are needed (SACN, 2015), the researcher didn't use the frequency in the current study. Unlike other previous studies such us the study of Joury et al (2016) where they reported the intake of free sugars in terms of frequency, which does not go line with the WHO (2015) recommendation report on free sugars intake.

The findings from the current study indicate that the level of free sugars intake among many White British adults in the UK is higher than that recommended by WHO (2015) and PHE (2015). The average intake of the free sugars among the samples was 57g/day, which is more than the recommended intake for adults (i.e., 30g/day). The findings of this report are similar to findings of the previous studies by UK National Diet and Nutrition (Bates et al, 2014) and the Defra report (Department for Environment, 2014a; 2014b; 2015a; 2015b; 2017a; 2017b; Leung and Stanner, 2011). These findings from the current study and previous studies suggest the need to orient more interventions to adult populations and the intervention should be based on a psychological theory that mirrors the complexity of free sugars intake. The Behaviour Change wheel and its tools could offer a solution for reducing free sugars intake.

This study measured the social class status of the respondents. According to the findings, the traditional working class had the highest proportions (84%) of individuals who consume high free sugars intake. Similar findings were found in other previous studies where individuals with lower income (<£20000/year) consume more free sugars compared with those with higher income (>£40000/year) (Bates et al, 2014; Barrett et al, 2017). These findings indicate improving socioeconomic of poor class can help in reducing free sugars intake. Although the traditional working class consumes high free sugars intake, they statistically have high proportion of individuals with free from dental filling (77%) with $X^2 = 15.55$ and $P = 0.00$. However, the means of measuring dental filling in this study which is through question is considered to be weak method for many major biases which are recall, awareness of dental caries status, hiding the truth about their conditions. Recall bias, respondents might not recall if they removed tooth with dental filling or had White filling that matches with their nature could not distinguish between them. Awareness

of dental caries status by the patients; dental caries can form on enamel where patient might not know because they would not feel any pain. Patient might hide their dental conditions to avoid embarrassment or fear from dentists (Moore, Brødsgaard, & Rosenberg, 2004). Therefore, the researcher would not rely on the findings related to Dental filling for research implications; it can be used as assumption or hypothesis.

Different educational levels were reported in the current study. Respondent with low educational levels A level or diploma had the highest free sugars intake compared to other respondents with high level of educations such as undergraduate or postgraduate. Similar finding with reported by Barrett et al, (2017) in their cohort study of 9991 adults where they reported the association between low level of education and high intake of sugar-sweetened beverages and artificial-sweetened beverage. Statistically, the findings of the current study also found that the level of education is significantly associated with level of free sugars intake with X^2 =12, P<0.001. These findings mean that increasing level of education could help in reducing free sugars intake.

Previous studies such as Barrett et al (2017) indicated that men consume more free sugars than women. Similar findings from the current study limited proportion but not statistically significant of men consume more free sugars than women. One of the possible reasons is that women are more conscious than men when consume free sugars (Hattersley et al, 2009). However, the findings from the current study indicate that gender might not play a major role in reducing free sugars intake. Possible more cohort studies would be required to assess the association between free sugars intake and gender.

Age plays a role in the consumption of free sugars intake as indicated in previous studies for example, Barrett et al, (2017) reported that younger adults consume higher sugar-sweetened beverages and artificial sugar-sweetened beverages when compared with older adults. In contrary, the current study found that there was no positive association between age and free sugars intake. The finding could not statistically establish the association between age and free sugars intake; however, the findings proportionally indicate that old adults consume the highest free sugars than young and

middle-aged adults. These findings are similar to the findings of the Defra report (Department for Environment, Food & Rural Affairs, 2017), where a positive association between Non-milk extrinsic sugars and young age could not be found and old adults aged between 65-74 proportionally consumes more Non-milk extrinsic sugars than young adults (Department for Environment, Food & Rural Affairs, 2017). In addition, looking at the previous studies such as Barrett et al, (2017), they only measured free sugars intake from drinks sources including SSDs without measuring other sources of free sugars intake which is sugary foods a big source of free sugars for adults than the drinks (Bates et al, 2014).
Another possible explanation for the differences between the findings of the current study with other previous studies is the underreporting of the actual intake by the respondents for various reasons; this is the case with self-reported questionnaire. (Sigman-Grant and Morita, 2003; Banna et al, 2015; Castro-Quezada et al, 2015). For instance, respondents could hide the actual intake to avoid any kind of embarrassment. Final possible explanation would be the doubt on the validity and reliability of the FFQ in accurately measuring the actual intake compared with biomarkers (Bingham et al, 2007; Tasevska et al, 2014; Tasevska, 2015; Beasley et al, 2015).

The current study found that household is scientifically associated with the free sugars intake; in which individuals who own or just to own a house consume more free sugars intake than individuals who rent from private houses or flat. One of the possible explanations is that the individuals who own a house feel secured and relaxation which drive them to consume more free sugars than individuals who do not own a house.

9.3.4. Differences among high and lower free sugars intake with TDF

One of the aims of the current study was to assess the differences between high, low free sugars intake in the TDF domains of reducing free sugars intakes. There were significant differences in the following domains which are discussed later: knowledge, physical skills, social influence, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role and identity (Automatic motivation), and emotions.
In the *Knowledge domain,* respondents who had high free sugars intake scored higher

mean of knowledge compared with respondents who had low free sugars intake. The findings suggest that knowledge in itself is not sufficient to control free sugars intake. Although findings of some previous studies such as Madiba, Bhayat, and Nkambule, (2017) contradicts with the current study findings, the systematic review Gupta et al (2018) support the suggestion of the current study. They found weak evidence that a change in Knowledge, would lead a change in the behaviour.

In the *physical skills and beliefs about capabilities domains*, respondents who had high free sugars intake scored lower mean in both domains compared with respondents who had low free sugars intake. The findings suggest that physical skills and beliefs about capabilities factors play important role in the control free sugars intake. The influences of physical skills and beliefs about capabilities on behaviour change have been reported in many different studies from difference models.

In the *social influence and environment context and resources domains* respondents who had high free sugars intake scored higher mean in both domains compared with respondents who had low free sugars intake. The findings suggest that social and environment context and resources factors play important role in the free sugars intake.

In the *beliefs about consequences domain* the respondents who had high free sugars intake scored high mean in the domain compared with respondents who had low free sugars intake. The findings suggest that beliefs about consequences, could influence free sugars intake.

In *the intention domain social and professional role and identity (Automatic motivation) and emotions domains the* respondents who had high free sugars intake scored high mean in the domains compared with respondents who had low free sugars intake. The findings suggest that the intention domain social and professional role and identity (Automatic motivation) and emotions factors, influence free sugars intake.

In summary, there are differences between high and low consumers of free sugars intake in knowledge, physical skills, social influence, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role and identity (Automatic motivation), and emotions domains. However, these differences in t domains, means that the domains influence free sugars intake but it doesn't mean they absolutely predict the intake of free sugars. The predictability of these domains is discussed in sections 9.3.7. to 9.3.10.

9.3.5. Differences among the groups within each demographic data with TDF

There were differences between the groups in the Theatrical Domains Frameworks (TDF) related to reducing free sugars intake in the following demographic data: White ethnicity, employment, age, gender, qualification, dental filling status, dental filling history, BMI, Social Class. In the *ethnicity*, there was difference between White British and other White in the memory attention, decision processes domain only. This is because the groups have similar interest and culture background.
In the *employment* section, there were many differences between King's College London, Non- King's College London, and unemployed staff in the following domains: **Psy**chological Skills, Physical Skills Social Influence, Environment Context and Resources, Beliefs About Capabilities, Beliefs About Consequences, Intention, and Reinforcement. These differences were stronger between King's College London, and Non- King's College London. In the *age* section, there were differences between young, middle aged and old adults in following domains: Psychological Skills, Social Influence, Environment Context and Resources, Beliefs About Consequences, Intention, Optimism, Social and Professional Role and Identity (Automatic), Reinforcement, and Emotions. In the *gender* section, there were difference between men and women in the three domains only: Physical Skills, Beliefs About Consequences, and Intention. In the *qualification* section, there were differences between A level or Diploma, Undergraduate and Postgraduate levels in the following domains: Knowledge, Physical Skills, Social Influence, Environment Context and Resources, Beliefs About Capabilities, Beliefs About Consequences, Intention, Social and Professional Role and Identity (Automatic), and Emotions. In the *Dental Filling Status*, there were differences between respondents with and without Dental Filling in the following domains: Social Influence, Intention, Emotions, Social and Professional Role and Identity (Automatic). However, in term of *Dental Filling History* there were differences between One year and less, 2-3 years, and 4 years and more in the following domains: Psychological Skills, Physical Skills, Social Influence, Beliefs About Consequences, and Reinforcement. For *Body Mass Index (BMI*) there were differences between Under Weight, Health, Over Weight, and Obese in only two domains: Beliefs About Consequences, and Emotions. In terms of *Social Class*, there were many differences between Precariat, Emergent service workers, Traditional

working class, New affluent workers, Middle class, Elite in the following domains: Psychological Skills, Physical Skills, Social Influence, Environment Context and Resources, Beliefs About Capabilities
Beliefs About Consequences, Intention, Social and Professional Role and Identity (Automatic), Reinforcement, and Emotions
There was no significant difference between the five districts in the UK among the respondents.

These differences between the groups indicate how important to include as much as possible all groups within each demographic data.

9.3.6. Correlation between TDF factors and free sugars intake

The findings of the current study indicated that not all TDF domains of reducing free sugars intake are significantly correlated to free sugars intakes; the correlation various among these domains. The environment context and resources domain related to free sugars intake were the positively the strongest factor correlated with free sugars intake. The second factor that was positively correlated to free sugars intake is the social and professional role and identity related to automatic motivation component of COM-B model, which is considered to be almost %51 of the explained variance in free sugars intake. Also, Intention and emotions were strong correlated to free sugars intake. Although knowledge domain was significantly positive correlate to free sugars intake, the correlation was the weakest among the other domains positive correlated with free sugars intake. This means findings suggest that knowledge alone is insufficient to reduce free sugar among the White ethnic groups in the UK. In contrary, the environment context and resources, social and professional role and identify of the automatic motivation, intention and emotions related to reduce free sugar intake could help in reducing free sugar intake among the groups. The findings of the current report are supported by previous systematic reviews where knowledge has weak evidence of changing behaviour for long term and possible other factors like environment played important factor in free sugars intake (Kay and Locker, 1997; Hubbub and Krishnappa, 2015; Kay et al, 2016; Gupta et al, 2018)

9.3.7. TDF Prediction on Free Sugar Intake Overall

The findings of the current study support the hypothesis in which The TDF factors predict free sugars intake and there is various between these factors in their predictability. The stepwise multi linear regression identifies six TDF Domains that are significantly predicts free sugars intake among White ethic groups. The domains are Environment Context and Resources; Social and Professional Role and Identity (Automatic Motivation); Social and Professional Role and Identity (Reflective Motivation); Reinforcement; Beliefs About Consequences; and Beliefs About Capabilities which all of them explained 48 % of free sugars intake among the White ethnic groups. However, not all of these predictors contribute positively to free sugars intake. The reinforcement, beliefs about capabilities and social and professional role and identity (Reflective Motivation) predictors have negative contributions to free sugars intake. This means that the current study suggesting that the increase score of reinforcement, beliefs about capabilities and social and professional role and identity (Reflective Motivation) factors would decrease the intake of free sugars intake. However, the effects of these factors various as indicated in the table 52. Unlike Environment Context and Resources; Social and Professional Role and Identity (Automatic Motivation) and Beliefs About Consequences, where the increase score of these factors contribute to an increase of free sugars intakes, but the effects of these factors various as indicated in the table 52. Further regression analysis enter method was carried out to identify the explanation of the six predictors which were identified from the stepwise model on free sugars intakes. The analysis revealed five of the six predictors were significantly predicting free sugars intake and three of them had the highest explanation of free sugars intake.

The environment context and resources predictor explained 27% of the free sugars intake; social and professional role and identity (automatic motivation) predictor explained 26% of the free sugars intake; beliefs about Consequences predictor explained 20% of the free sugars intake; beliefs about capabilities explained 4% of the free sugars intake and Reinforcement predictor explained 1% of the free sugars intake. Intentions nor knowledge domains were not identified as significant predictors in the currently study. This is not in line with other previous studies were intention, action planning (behaviour regulation), perceived behavioural control, and attitude

were significantly predicted the free sugars intake (Astrøm , and Okullo, 2004; Hagger et al, 2017). These studies used models that did not count the context in which free sugars intakes take place such as environment. Unlike with the current study that suggested that the environment context and resources play important role in reducing free sugars intake. In the current study beliefs about capabilities explained 4% of the free sugars intake unlike with Astrøm , and Okullo, (2004) were they found that perceived behavioural control (beliefs about capabilities) explained 19% of free sugars intake. The Theoretical Domains Framework (TDF) has shown to be comprehensive in understanding and predicting the free sugars intake.

9.3.8. TDF Prediction on Free Sugars Intake Based on Gender grouping

The current study found that there is a difference between men and women in the prediction of free sugars intake among White ethnic adults. For women, the final prediction model for free sugars intake has the following predictors: Environment Context and Resources, Social and Professional Role and Identity (AM), Reinforcement, Beliefs About Consequences and Physical skills. In contrary with men the final prediction model for free sugars intake has the following predictors: Environment Context and Resources, Social and Professional Role and Identity (AM|), Social and Professional Role and Identity (RM) and Knowledge. Similar findings were found in the study of Kvaavik et al (2005), where prediction models of added sugars between men and women were different. These findings for both studies suggest that interventions development should not all be at population level, but there should be at individual level to meet the desired needs for the individuals and better intervention outcome.

9.3.9. TDF Prediction on Free Sugars Intake Based on Dental Filling Status Grouping

The current study found that there is a difference between respondents with dental filling and without dental filling in the prediction of free sugars intake among White ethnic adults. For respondents with dental filling, the final prediction model for free sugars intake has the following predictors: Social and Professional Role and Identity

(AM), Environment Context and Resources and Physical skills. In contrary with respondents without dental filling, the final prediction model for free sugars intake has the following predictors: Social and Professional Role and Identity (AM), Reinforcement, Beliefs About Consequences, and Social and Professional Role and Identity (RM). This is the first study that compares the prediction of free sugars intakes between respondents with dental filling and without dental filling. These findings suggest that interventions development should not all be at population level, but there should be at individual level to meet the desired needs for the individuals and better intervention outcome.

9.3.10. Dental Filling Prediction on Free Sugars Intake

The current study assessed the prediction of dental filling status on free sugars intake. It was found that not having dental filling is correlated with free sugars intake and considered almost %5 of the explained variance in free sugars intake. This is the first study that uses dental filling status as a predictor. Previous studies such as Astrøm and Okullo (2004), which explored the prediction of caries experience, found that high caries experience leads to weak intention to reduce free sugars intake.

9.3.11. Strengths and Limitations:

In many studies there are strengths and limitations and in the current study, there are seventh main strengths. The **first strength** is the steps used to develop the survey, which involved: literature review, qualitative data of the White ethnic groups, experts' opinions and piloting the survey. The **second** strength is the diversity of the demographic data collected which helped to make many analyses. Also, this takes to the **third** the survey has very rich data that can be used for further analyses in the future. The **fourth** strength is the use of theory based analyses TDF that has helped in understanding the behaviour of free sugars intake in much details and identity the predictors from the context of the behaviour. The **fifth** strength is the level of Cronbach's alpha, where majority of the TDF scales had the Cronbach's alpha between excellent and acceptable level. One of the major reasons is the huge number of items and inter-item correlation (DeVellis, 2017); also, through follow guidelines

from Qualtrics and experts. The **sixth** strength is the response rate was very high and different assumed reasons were mentioned previously for this very high response rate. The **Seventh** strength is **comparison** between low and high intake respondents. The **eighth** strength is sampling method simple random clustered method. However, there were some limitations. The **first** limitation is the use of self-reporting survey may not give the complete or actual picture of the phenomena should be analysed. The **second** limitation is the study missed population who cannot or have limited access to Internet for online survey. **Third** limitation is missing of many disadvantaged populations from the community, which have issues with free sugars intakes. **Fourth** limitation, the representation is not sufficient for generatability for the findings. Despite the steps taken to obtain a representative sample, the range of demographic characteristics in the sample was still narrow. This leads to the main limitation of both the qualitative and the quantitative studies was the representativeness of the samples. Both studies had a high proportion of participants with education at the tertiary level. Future studies should be conducted with a representative sample of the population.

9.4. Conclusion

In conclusion, the findings of the current study suggest that there are differences among high and lower free sugars intake White ethnic groups in the UK in the factors related to reducing free sugars intake based on TDF and COM-B model. Also, there are differences among the groups within each demographic data in the factors related to reducing free sugars intake based on TDF and COM-B model. The findings of the current study suggest there is significant association between groups of free sugars intake (high and lower) and the demographic data in the qualifications and house hold status. In addition, there are correlation between the factors related to reducing free sugars intake based on TDF and COM-B model and free sugars intake in the following domains: knowledge, psychological skills, memory attention and decision processes, physical skills, social influences, environment context and resources, beliefs about capabilities, beliefs about consequences, intention, social and professional role and identity (automatic motivation) and emotions. Six predictors were identified from the regression which are: Environment Context and Resources; Social and Professional Role and Identity (Automatic Motivation); Social and

Professional Role and Identity (Reflective Motivation); Reinforcement; Beliefs About Consequences; and Beliefs About Capabilities. However, based on the R square value, the most influential are: Environment Context and Resources, Social and Professional Role and Identity (AM) and Beliefs About Consequences. There were differences between men and women with and without dental filling in the predictors of free sugars intake among White ethnic adults in the UK. The findings from the study suggested to consider Environment Context and Resources, Social and Professional Role and Identity (AM) and Beliefs About Consequences factors related to reduce free sugars intake in the development interventions to reduce free sugars intake at population and individuals' levels. However, more studies should be conducted with a representative sample of the population of the study and clinical trials before attempt for interventions

10.Suggested Interventions

Based on the survey findings, the researcher proposed Environment Context and Resources, Social and Professional Role and Identity (AM) and Beliefs About Consequences domains for intervention development. The three domains were represented onto relevant lists of intervention functions, policy categories, behaviour change techniques; the BCW book was used a guide (Michie, Atkins, and West 2014). Table 52 presents the three domains mapped with intervention functions, policy categories, and behaviour change techniques.

Table 52: The three domains mapped with suggested intervention functions, policy categories, and behaviour change techniques:

Domains	Intervention Functions	Policy Categories	Behaviour Change Techniques.
Environment Context and Resources.	• Training • Restriction • Environmental Restructuring. • Enablement.	• Guidelines. • Fiscal Measures. • Regulation. • Legislation. • Service provision. • Environmental and Social Planning.	• Restructuring the physical environment. • Discriminative (learned) cue. • Prompts/ cues. • Restructuring the social environment. • Avoidance/ changing exposure to cues for the behaviour.
Social and Professional Role and Identity (AM).	• Education • Persuasion • Modelling	• Communication/ Marketing. • Guidelines. • Regulation. • Legislation. • Service provision.	No suggestion could be made
Beliefs About Consequences.			• Emotional Consequences. • Salience of Consequences. • Anticipated Regret. • Social and environmental Consequences.

			Comparative imagining of future outcome. • Vicarious Reinforcement. • Threat. • Pros and Cons. • Convert Conditioning.

11. Implication and Future Research:

11.1.Implication

From the systematic review, there is a need for high quality, theory-driven interventions to support clinical practice. The review has highlighted potential opportunities for researchers and intervention designers to explore and examine such approaches. Given the contribution of dietary sugars to caries development and the role of lifestyle change to combat dietary free sugars intake, there is a need for trials of theory-based interventions aimed at reducing individuals' consumption of dietary sugars.

From the qualitative study, many crucial factors that influence free sugars intake among the White ethnic adult population have been identified. This was through the use of COM-B model and TDF frameworks that have provided an inclusive account of the barriers and facilitators of reducing free sugars intake among White ethnic groups. This could be useful for the development of strategies to address specific facilitators and barriers of the implementation of interventions that aim to reduce free sugars intake to less than 5% of the total energy intake in relation to dental caries among White ethnic adults in the UK.

From the quantitative study, three main predictors which are Environment Context and Resources, Social and Professional Role and Identity (AM) and Beliefs About Consequences can be used to develop clinical trials aiming to reduce free sugars intake at population. Moreover, the study highlight that interventions based on knowledge attainment is insufficient to reduce free sugars intake. Also, the survey can be modified and developed to clinical tool to assess patient needs toward reducing free sugars intake.

Lastly, PhD project would have great contribution to the Omani society as I have developed many skills during PhD.

11.2.Future Suggested Researches

1. Similar research idea on wide ethnicities for more representation of UK ethnicity groups that could include black ethnicity and others. This can help to develop more tailored population interventions.
2. Similar research idea could be carried out at policy makers, health practitioners, and industry; combine the finding of this research with point one for better interventions that tackle the intake of free sugars.

3. As its mentioned before that this PhD Thesis has very enrich data both qualitatively and quantitatively which can be used for further analysis in the future.
4. The survey can be developed as clinical tool to assess individual free sugars intake from and tailored intervention at individual level.

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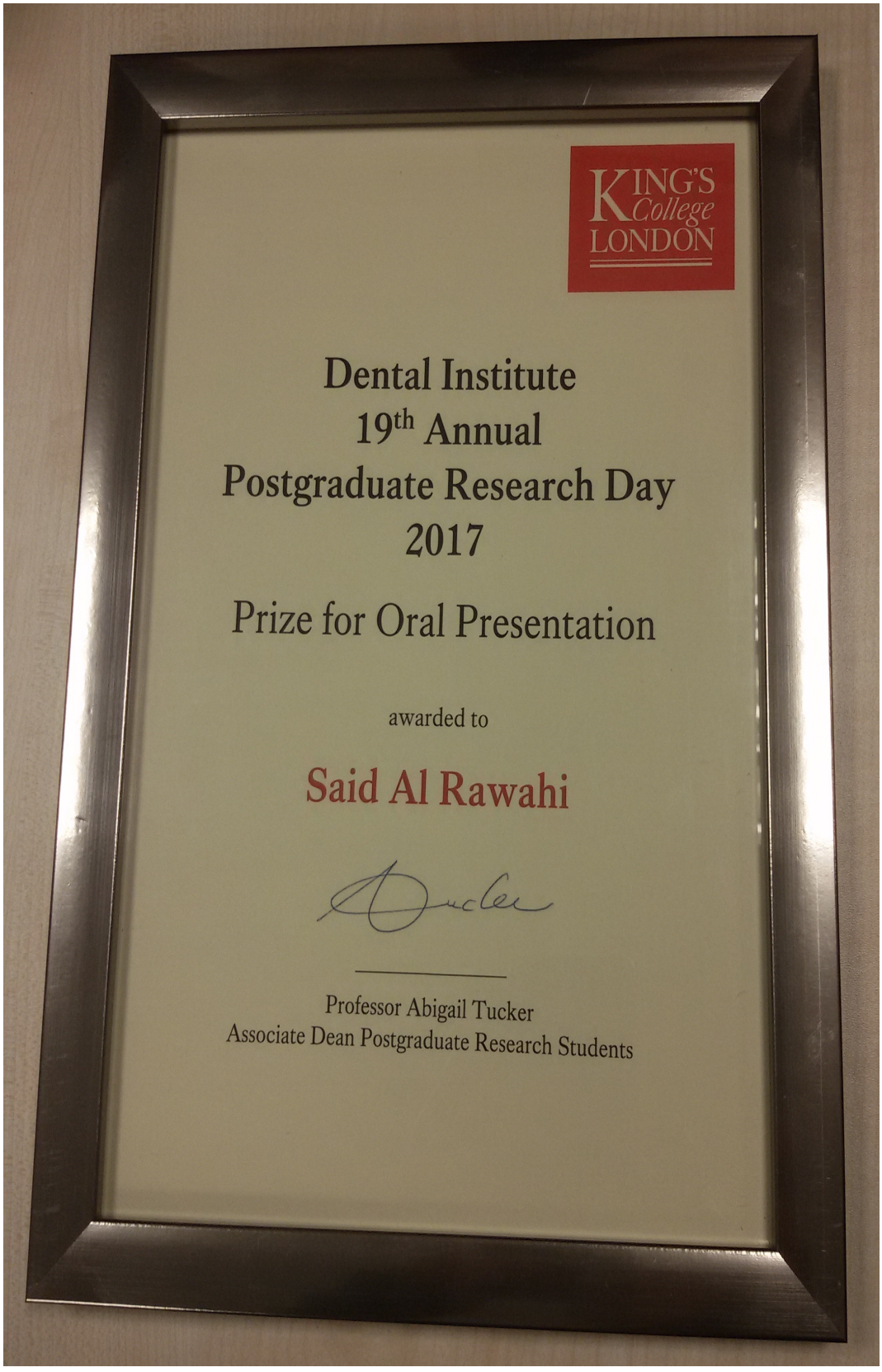
13.Appendices

13.1. List of Thesis-related Awards and Appreciation:

13.1.1. Prize for Oral Presentation Research 2017 19th PRD 2017


KING'S College LONDON
Dental Institute
19th Annual
Postgraduate Research Day
2017
Prize for Oral Presentation
awarded to
Said Al Rawahi
Professor Abigail Tucker
Associate Dean Postgraduate Research Students

13.1.2. The Awarded winning First Poster Presentation

13.1.3. Certificate of Appreciation from The Omani Embassy

The Cultural Attaché Office
Embassy of The Sultanate of Oman - London

Certificate of Appreciation

The Cultural Attaché of London is proud to present this certificate to

SAID HARITH SAID AL-RWAHI

in recognition of outstanding performance and personal achievements for the academic year 2016/2017.

Awarded on this day : 10 March 2018

H.E. Shaikh Abdulaziz Al Hinai
Ambassador of the Sultanate of Oman to the UK

Musallam AL Amri
Cultural Attaché

جمعية الطلبة العمانيين بمانشستر
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LCS
جمعية الطلبة العمانيين في ليدز
LEEDS OMANI SOCIETY

13.1.4. Selected as a successful Student's Achievement in the Dental Institute E-News

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ISSUE No. 013 • 13 April 2018

Dental Institute E-news

Dental Institute student peer-reviewed

Said Al Rawahi, a four year PhD student at the Institute, has had manuscripts published in two peer-reviewed journals.

Said receiving his Certificate of Appreciation from the Oman Embassy

Theory based interventions for caries related sugar intake in adults: systematic review by Said, along with Dr Koula Asimakopoulou and Jonathon Timothy Newton, was published in BMC Psychology, and *Factors related to reducing free sugar intake among white ethnic adults in the UK: a qualitative study* by Said, Koula and Jonathon was reviewed by BDJ Open.

Said received a note from BDJ Open stating: "It is unusual to be able to accept a manuscript for publication with no revision needed. This was a very high quality submission and both our reviewers recommended that we accept it."

Said had a very successful year in 2017, also winning the following awards:

The Prize for Oral Presentation at the 19th Annual Dental Institute Postgraduate Research Day
First place on the Post Competition at the Omani Open Day
The Certificate of Appreciation from The Oman Cultural Attaché of London.

13.2. List of Thesis-related Oral Presentations

13.2.1. ADRI 2018 London

IADR 2018 Symposium proposal.

Mohd Masood <M.Masood@latrobe.edu.au>

Tue 14/11/2017 12:09

To: Al Rawahi, Said <said.al-rawahi@kcl.ac.uk>;

Cc: Newton, Tim <tim.newton@kcl.ac.uk>;

1 attachments (16 KB)

IADR symposium Mohd Masood.docx;

Hi Said
I am submitting a symposium proposal at IADR 2018. Please see the attached file.
Would you like to talk on the topic "Clinical and behavioral approaches to reducing sugar intake"?
Please let me know as soon as possible.

Best Wishes

Masood Mohd PhD, MSc, DDPH, BDS

Senior Lecturer
Department of Dentistry and Oral Health
La Trobe University
Australia
T +61 3 5444 7594 I **M** +61466976786 I **E** m.masood@latrobe.edu.au

2018 IADR/PER General Session Co-Author Abstract (2885172)

meetings@iadr.org

Wed 15/11/2017 10:12

To: Al Rawahi, Said <said.al-rawahi@kcl.ac.uk>;

Wednesday, 15-Nov-2017

Dear Dr. Said Al Rawahi,

An account has been created for you on the 2018 IADR/PER General Session & Exhibition submission site because you are listed as a co-author of submitted abstract or a session proposal speaker of control ID 2885172, "Clinical and Behavioral Approaches in Reducing Sugar Intake."

To view the proof:

Please log into your ScholarOne account, through the Member Portal at https://www.iadr.org/My-IADR. Once you have logged into the Member Portal, click the "Abstracts and Proposals Submission-2018 IADR/PER General Session (London, England)" link under Meetings-Abstracts Submission & Registration.

Once in your ScholarOne account, to the right of your name in the upper right corner, you will see Messages (New). Click this button to review a drop down menu. Select "View Emails". The page will refresh and you will see all of the messages that have been sent to you from the ScholarOne site. Select "View Abstract" under the Action column for the emails that have been sent to you.

Please contact meetings@iadr.org if you have any additional questions.

Sincerely,
Kourtney Skinner, Senior Manager, Publications & Abstracts
meetings@iadr.org
2018 IADR/PER General Session & Exhibition


Said.Al-Rawahi@KCL.AC.UK
Thank you.

13.2.2. BAODR2017 Plymouth

Gmail ABUSAIF AlRawahy <said.dsa.ihs@gmail.com>

2017 BSODR Annual Meeting Abstract Decision (2761658)

peter.g.robinson@bristol.ac.uk <peter.g.robinson@bristol.ac.uk> Sat, Jun 17, 2017 at 7:40 PM
Reply-To: peter.g.robinson@bristol.ac.uk
To: said.dsa.ihs@gmail.com

Saturday, 17-Jun-2017

Dear Mr. Said Al Rawahi,

It is a pleasure to accept your submission (2761658) entitled "Factors Related to Reducing Free Sugar Intake Among White Ethnic Adults: Barriers and Facilitators
" for presentation at the BSODR-IADR17/ British Society for Oral and Dental Research in Plymouth.

An email confirming the day and time of your presentation will be forwarded to you in due course.

Thank you for your fine contribution. On behalf of the 2017 BSODR Annual Meeting Program, we look forward to your continued contributions.

Sincerely,

Peter Robinson
Editor, BSODR

(This is an automatically-generated email intended for said.dsa.ihs@gmail.com)

BSODR Plymouth 2017
Oral Presentations & Poster Sessions

Wednesday 6th September

Wednesday, September 6, 2017 02:00 PM-03:30 PM Roland Levinsky Theatre 2
Senior Colgate Heat 1

001 Periodontitis Severity Associated with Cardio-Renal Health in Renal Disease Patients.
Sharma, P.[1], Fenton, A.[3], Sidhu, A.[1], Rahman, M.[1], Cockwell, P.[2], Ferro, C.[2], Chapple, I. L.[1], Dietrich, T.[1]
[1]University of Birmingham, , [2]University Hospital Birmingham

002 Mechanical Properties of Dental Composites Modified by Incorporation of Fluorapatite Micro-rods.
Al-Taie, A.[1], Bubb, N.[1], Franklin, P.[1], German, M.[2], Wood, D. J.[1]
[1]School of Dentistry, University of Leeds, [2]School of Dental Sciences, University of Newcastle

003 Radiographic Estimation of Remaining Dentine Thickness in Carious Primary Molars.
Almutairi, W.[1], Douglas, G. V.[1], Lancaster, P.[1], Day, P. F.[1, 2]
[1]University of Leeds, [2]Community Dental Service, Bradford District Care NHS Foundation Trust

004 Factors Related to Reducing Free Sugar Intake Among White Ethnic Adults: Barriers and Facilitators.
Al Rawahi, S., Asimakopoulou, K., Newton, J. T.
King's College London Dental Institute

005 Is the sense of taste impaired in Sjogren's Syndrome patients?
Al-Ezzi, M. Y.[1], Khan, K.[2], Tappuni, A. R.[1]
[1]Queen Mary University of London, [2]Blizard Institute

006 Dentists' Perceptions of Their Roles Influence Their Patient Referral Decisions.
Allen, Z.[1], Moles, D. R.[1], Nasser, M.[1], Richardson, J.[1]
[1]Plymouth University Peninsula Schools of Medicine and Dentistry

13.2.3. KCL DI Research Day 2017

King's College London Dental Institute

19th Annual Postgraduate Research Day

Tower Wing, Guy's Campus

Wednesday, 8th March 2017

Session CDS3: Lecture Room Floor 18 *Chair: Marcus Dawson*	*Session PPH2: Seminar Room 1 Floor 18* *Chair: Summaya Alrawiai*	
Craniofacial Development & Stem Cell Biology 3	**Population and Patient Health 2**	
15:00 CDS10 – Christoph Salzlechner A novel tissue-engineered regenerative strategy for targeting degenerative diseases of the TMJ.	----	—
15:15 CDS11- Emily Lodge Hippo kinases in the pituitary	**15:15 PPH4 – Anqi Shen** The association between dental caries and anthropometric measurements among 3-5 years old Chinese children in Shenyang City	—
15:30 CDS12 – Kimberley Reigman The epigenetic regulation of mouse cerebellar development	**15:30 PPH5 – Said Al Rawahi** Barriers and Enablers to Behavioural Change to Reduce Free Sugar Intake related to Dental Caries Among White Ethnic Adults	—
15:45 CDS13 – Mushriq F. Abid Genetics of supplemental non-syndromic supernumerary lateral incisors	**15:45 PPH6 – Shahinaz Sembawa** Motivation, career expectations and influences of Saudi females in dentistry	----
16:00 – 16:20 BREAK Move to Lecture Theatre Floor 30		

13.2.4. KCL DI Research Day 2016

King's College London Dental Institute

18th Annual Postgraduate Research Day

Tower Wing, Guy's Campus

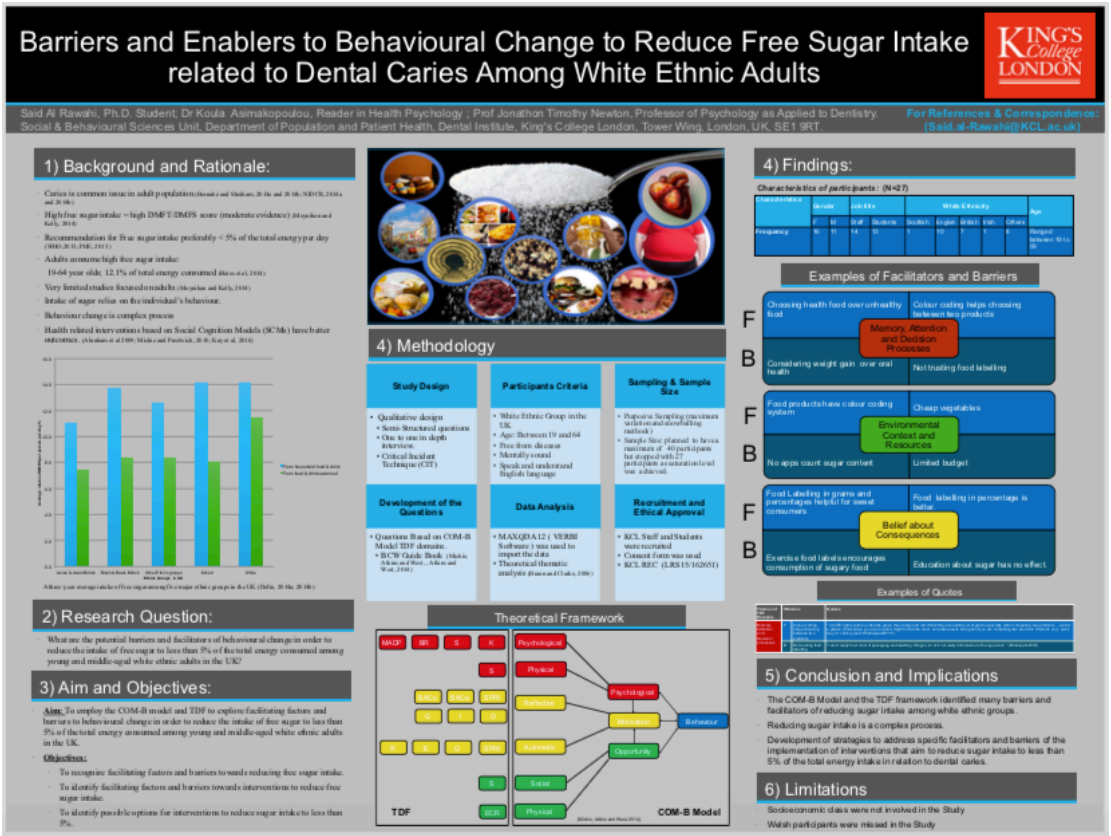
Wednesday, 9th March 2016

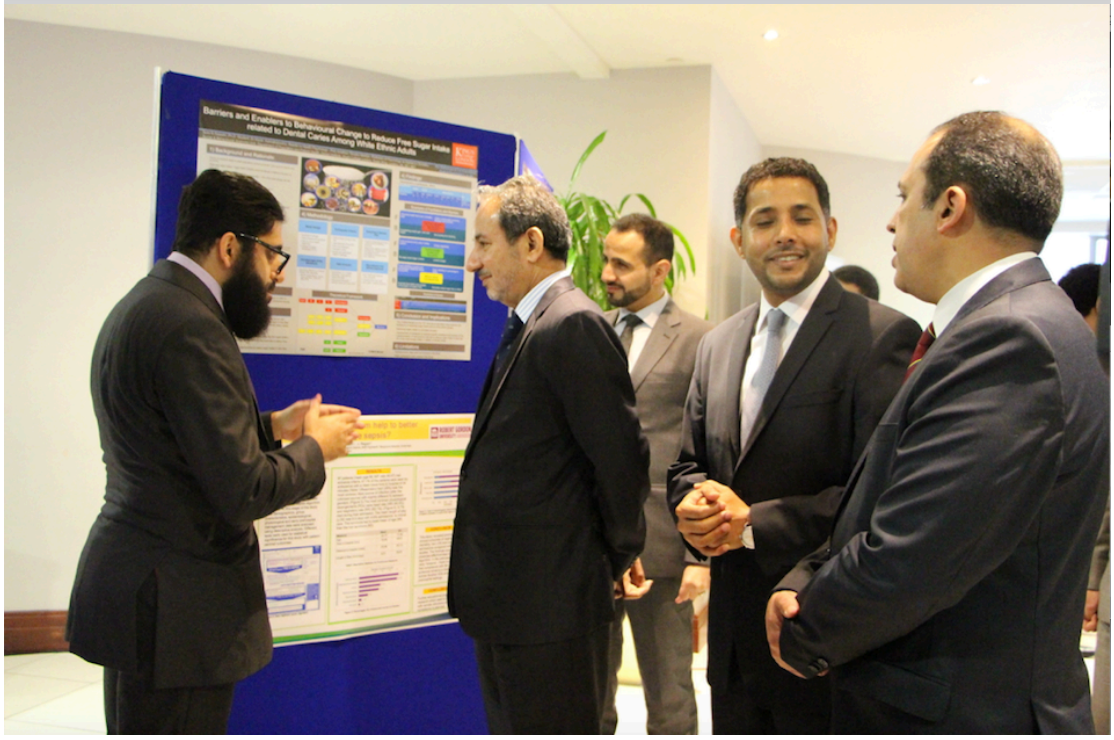
10:40 – 11:10 AM Registration *Function Room Floor 18*

Session D1: Lecture Room Floor 18 *Chair: Mark Hintze*	*Session D2: Seminar Room 1 Floor 18* *Chair: Sorrel Bunting*	*Session E1: Seminar Room 2 Floor 18* *Chair: Jonathan Turner*	*Session O1: Board Room Floor 18* *Chair: Arshiya Banu*
Development, Disease & Stem Cells 1	**Development, Disease & Stem Cells 2**	**Dental Education, Practice & Policy 1**	**Oral Environment 1**
11:15 D1- Alice Gervasoni Hair Cell loss: an epigenetic approach	**11:15 D6- Doris Cuckovic** The role of Gas1 in murine salivary gland development	**11:15 E1- Afnan Ben Gassem** Evaluating the Effects of Information Provision on Hypodontia Patients' Expectations of the Process and Outcome of combined Orthodontic and Restorative Treatment	**11:15 O1- Hayder Saloom** Biochemical markers in saliva, gingival crevicular fluid and blood of the obese and non-obese orthodontic patients
11:30 D2- Ana Lopez Muñoz GSK3 and Neural Crest migration	**11:30 D7- Elena Popa** Revitalization of the mouse molar dental lamina	**11:30 E2 - Ellie Heidari** How does dental phobia affect oral health and oral health related quality of life (OH-QoL)?	**11:30 O2- Jack Houghton** Sensory Effects of TRP Channel Agonists on Salivary Secretion
11:45 D3- Bahareh Ghasemi Role of MicroRNAs in Mesenchymal stem cell fate decisions	**11:45 D8- Basem Akily** Role of Wnt signaling in adult mice incisor growth	**11:45 E3- Said Al Rawahi** Interventions Based on Psychological Models of Health Related Behaviour to Reduce Sugar Intake Related to Dental Caries in Adults: A Systematic Review.	**11:45 O3- Mahdi Mutahar** Salivary proteins mediate greatest protection against dental erosion
12:00 D4- Emily Lodge Hippo signalling during pituitary development	**12:00 D9- Hersi Mohamed Hersi** Role of miR-9 as a predictive biomarker of tumour progression and response to therapy in head and neck cancers	**12:00 E4- James Coxon** The assessment of specialist paediatric dentist's knowledge of behavioural management principles	**12:00 O4- Marianna Blagojevic** Candidalysin induces epithelial cell death during mucosal infection
12:15 D5- Daniel Doro Identifying osteogenic cues in calvarial development	**12:15 D10- William Barrell** The role of primary cilia during osteo-chondrogenic differentiation	------	**12:15 O5- Matt Blakeley** Salivary vitamin-binding proteins & systemic vitamin status
12:30 – 13:30 **LUNCH: FUNCTION ROOM**	**12.50- 13.20 Talk by 33,000 Everyday Artists in Board Room- take you lunch along.**		

13.3. List of Thesis-related Poster Presentation

13.3.1. Omani competition UK universities





13.4. List of Thesis-related publications

13.4.1. Systematic Review protocol

UNIVERSITY of York
Centre for Reviews and Dissemination

NHS
National Institute for Health Research

PROSPERO International prospective register of systematic reviews

Interventions based on psychological models of health related behaviour to reduce sugar intake related to dental caries in adults: a systematic review

Said Al Rawahi, Timothy Newton, Koula Asimakopoulou

Citation
Said Al Rawahi, Timothy Newton, Koula Asimakopoulou. Interventions based on psychological models of health related behaviour to reduce sugar intake related to dental caries in adults: a systematic review. PROSPERO 2015:CRD42015026357 Available from http://www.crd.york.ac.uk/PROSPERO_REBRANDING/display_record.asp?ID=CRD42015026357

Review question(s)
Do interventions based on Social Cognitive Models (SCMs), or their constructs, improve caries related dietary behaviours in adults when compared with educational interventions?

What is the effect of interventions based on Social Congitive Models (SCMs) on sugar intake in adults, when compared with educational interventions or no intervention?

Searches
• The Cochrane database including: Oral Health Group's Trials Register (2015),

• MEDLINE (from 1966 to September 2015),

• EMBASE (from 1980 to September 2015),

• PsycINFO (from 1966 to September 2015).

There will be no language restriction

Types of study to be included
Randomised Controlled Trials

Controlled Clinical Trials

Before and after studies

Condition or domain being studied
Dental Caries

Participants/ population
Adults aged 18 years and above

Intervention(s), exposure(s)
Theories and models of behaviour change (Davis et al, 2014; Munro, 2007; Ogden, 2004; Forshaw, 2002) can possibly help to understand individuals behaviours related to oral health. By understating the patterns of behavior change, effective strategies (NICE, 2007) at the individual level can be developed that may help in maintaining good oral hygiene. Applications of these models and theories in health related behaviour interventions have shown to be more productive when compared with non-theory based interventions (Abraham et al 2009).

There have been many applications of behaviour change theories aimed at improving oral hygiene practice among adults (Newton and Asimakopoulou, 2015). In particular, Social Cognitive Models (SCMs) help to understand individuals' behaviour, thoughts, beliefs, and attitudes (Conner & Norman 2005). SCMs are favoured because they

focus on individuals, rather than groups or systems, and this takes into account the individuals needs and differences, which may maximise the success of behavioural change.

Comparator(s)/ control
Health Education interventions or non

Context
Oral health educational (non-psychological theory based) interventions, no intervention controls.

Outcome(s)
Primary outcomes
• Behavioural outcomes: reduction of sugar intake, assessed by any method, including self-report, food diary, observation etc.

• Attitude and belief outcomes:

o Primary outcomes: Patients' attitudes, beliefs and their intentions towards sugar intake related to dental caries.

sustain the improvement for one year

Secondary outcomes
For permanent dentitions which are: tooth decay increment, DMFS and DMFT scores, filled teeth which includes replaced restorations, early carious lesions which are arrested or reversed, and root caries.

Data extraction, (selection and coding)
Data will be collected for each study on a data sheet, which includes the following data points:

• Study Design

• Sample size

• Psychological constructs assessed and theoretical framework adopted

• Measures of primary and secondary outcomes

• Effect of intervention on outcomes

Two authors will independently extract data, following the guidance of the Cochrane reviewers' handbook checklist (Higgins and Deeks.. 2008)

Risk of bias (quality) assessment
Cochrane reviewers' handbook checklist will be used (Higgins et al. 2011) to assess the risk of bias interventional trials.

Strategy for data synthesis
If a sufficient number of homogeneous studies meet the inclusion criteria, and have accessible effect sizes, a quantitative meta-analysis will be conducted.

Analysis of subgroups or subsets
None planned

Dissemination plans
via publication

Contact details for further information
Mr Al Rawahi

Social & Behavioural Sciences Unit, Department of Population and Patient Health, Dental Institute, King's College London, Tower Wing, London, SE1 9RT

said.al-rawahi@kcl.ac.uk

Organisational affiliation of the review
King's College London

www.kcl.ac.uk

Review team
Mr Said Al Rawahi, King's College London
Professor Timothy Newton, King's College London
Dr Koula Asimakopoulou, King's College London

Anticipated or actual start date
17 September 2015

Anticipated completion date
16 March 2016

Funding sources/sponsors
This systematic review is part of the first author's PhD studies, generously funded through Ministry of Health, Oman

Conflicts of interest
None known

Language
English

Country
England

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Adult; Dental Caries; Diet; Humans; Models, Psychological

Stage of review
Completed but not published

Date of registration in PROSPERO
21 September 2015

Date of publication of this revision
18 March 2016

DOI
10.15124/CRD42015026357

Stage of review at time of this submission	Started	Completed
Preliminary searches	Yes	Yes
Piloting of the study selection process	Yes	Yes

Formal screening of search results against eligibility criteria	Yes	Yes
Data extraction	Yes	Yes
Risk of bias (quality) assessment	Yes	Yes
Data analysis	Yes	Yes

Al Rawahi *et al. BMC Psychology* (2017) 5:25
DOI 10.1186/s40359-017-0194-z

BMC Psychology

RESEARCH ARTICLE Open Access

Theory based interventions for caries related sugar intake in adults: systematic review

Said Hartih Al Rawahi*, Koula Asimakopoulou and Jonathon Timothy Newton

Abstract

Background: Theories of behavior change are essential in the design of effective behaviour change strategies. No studies have assessed the effectiveness of interventions based on psychological theories to reduce sugar intake related to dental caries. The study assessed the effect of interventions based on Social Congition Models (SCMs) on sugar intake in adults, when compared with educational interventions or no intervention.

Methods: A range of papers were considered: Systematic review Systematic Reviews with or without Meta Analyses; Randomised Controlled Trials; Controlled Clinical Trials and Before and after studies, of interventions based on Social Cognition Models aimed at dietary intake of sugar in adults. The Cochrane database including: Oral Health Group's Trials Register (2015), MEDLINE (from 1966 to September 2015), EMBASE (from 1980 to September 2015), PsycINFO (from 1966 to September 2015) were searched.

Results: No article met the full eligibility criteria for the current systematic review so no articles were included.

Conclusion: There is a need for more clinical trials to assess the effectiveness of interventions based on psychological theory in reducing dietary sugar intake among adults.

Systematic Review Protocol Registration: PROSPERO: CRD42015026357.

Keywords: Social cognition model, Behavioural science, Adult, Dental caries, Free sugar intake, Systematic review

Background

Theories of behavior change [1–4] are essential in the design of effective behaviour change strategies. Such theories [5, 6] can be helpful in improving our understanding of how behaviour change might lead to a healthy lifestyle. Interventions based on such models have been shown to predict behaviour change better than non-theory based interventions [7].

Social Cognition Models (SCMs) are a subgroup of psychological theories, which are based on the assumption that the individuals' attitudes and beliefs towards a behaviour are strongly predictive of the likelihood of them engaging in that behaviour [8]. Interventions based on such models have been shown to improve dietary behaviours related to general health in highly selected patient groups. For example, Stacey and his colleagues [9] conducted a systematic review and meta-analysis to assess the effectiveness of physical activity and dietary change interventions based on Social Cognitive Theory among individuals who had survived a cancer diagnosis. The study showed that most of the included interventions were effective for enhancing dietary behaviour and physical activity. The authors, concluded that interventions based on psychological theories are effective in changing behaviour.

In oral health, two comprehensive systematic reviews have been conducted to assess the effectiveness of interventions based on SCMs, which aimed to improve adherence to oral hygiene related behaviours in adults with periodontal diseases. In the first systematic review, Renz and colleagues [10] reported that the low quality of studies associated with SCTs, made it difficult to draw any conclusions about SCT model efficacy. In the second systematic review, Newton and Asimakopoulou [11]

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Social & Behavioural Sciences Unit, Department of Population and Patient Health, Dental Institute, King's College London, Tower Wing, London SE1 9RT, UK

identified that self-efficacy, goal setting, and planning were the most effective constructs for improving oral health behaviour in periodontal patients. This suggests that at least some components of SCMs may be effective for predicting oral health behaviors regardless of the overall theoretical framework which they were part of [12].

However, upto date there is no published systematic review of the effectiveness of interventions based on psychological models of health related behaviour to reduce sugar intake related to dental caries in adults. Dental caries is a prevalent issue that affects the majority of the adult population around the world [13–15]; for instance in the US more than 84% of adults have some caries experience [16] and the average Decayed, Missing, Filling Tooth (DMFT) score of adults in the UK of adults aged between 35 and 44 year olds is 11.57 [17, 18]. On the basis of a systematic review, Moynihan and Kelly [19] concluded that reducing daily free sugars intake to less than 10% of total energy would reduce the prevalence of dental caries; a further reduction to less than 5% may prevent the progression of dental caries in the long-term. The relationship between sugar intake and caries remains strong even with the application of fluoride as a preventive strategy [19], emphasizing the importance of lifestyle interventions to reduce sugar intake.

Achieving the target consumption of free sugars is likely to require behaviour change by individuals, and the dental team can play an important part in assisting people to achieve this. The aim of the current systematic review is to examine the effectiveness of interventions based on Social Congitive Models (SCMs), aimed at reducing sugar intake related to dental caries among adults. The review aims to rectify this by addressing the following question: What is the effect of interventions based on Social Congitive Models (SCMs) on sugar intake in adults, when compared with educational interventions or no intervention?

Methods

The current systematic review was registered with the International Prospective Register of Systematic Reviews (PROSPERO), 2015 database (CRD42015026357). The reporting of the review is based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) [20].

Eligibility criteria:

- *Types of studies*
  - Systematic Reviews with or without Meta Analysis
  - Randomised Controlled Trials
  - Controlled Clinical Trials
  - Before and after studies
- *Types of interventions*

This review included interventions based on the following psychological theories and models of health related behaviour:

  - Health Belief Model (HBM)
  - Theory of Reasoned Action (TRA)
  - Theory of Planned Behaviour (TPB)
  - Self Efficacy Model
  - Transtheoretical Model (Stages of Change)
  - Protection Motivation Model
  - Health Locus of Control (HLOC)
  - Implementation Intentions
  - PRIME (Plans, Responses, Impulses, Motives, Evaluation) Theory of Motivation
  - Unrealistic Optimism Bias
  - Self Regulatory Model
  - Health Action Process Approach (HAPA)
  - Precaution Adoption Process Model (PAPM)
  - Outcome Expectancy
  - Hypothesis Model of Compliance
  - Social Cognitive Theory
  - Information Motivation Behaviour Skills Model (IMBM)
  - Operant and Classical Conditioning
  - Interventions adopting techniques from Cognitive Behaviour Therapy
  - Motivational Interviewing
  - COM-B (Capabilities, Opportunities, Motivations, Behaviour) Model
  - Behaviour Change Wheel (BCW)
- Papers were included if they clearly stated that one of the above psychological models or theories was used and at least one construct identified in the theory or the model was targeted in the intervention.
- Sugars were defined "as any of: total sugars, free sugars, added sugars, sucrose, non-milk extrinsic (NME) sugars, expressed as g or kg/day or /yr or as percentage E." [19; p.1]
- *Comparison:* oral health educational (non-psychological theory based) interventions, or no intervention controls.
- *Types of participants*
- Adults aged 18 or over.
- Patients with or without dental caries. For the aim of this review, dental caries is defined on the basis of diagnosis from a dental clinician. This includes diagnoses of any caries lesion active, progressive or arrested, which includes root caries.

Outcome measures:

Three outcome measures were considered to determine adults oral health related behaviours for this review [21].

Behavioural outcomes: reduction of sugar intake, assessed by any method, including self-report, food diary, observation etc.

Attitude and belief outcomes:

Primary outcomes: Patients' attitudes, beliefs and their intentions towards sugar intake related to dental caries.

Clinical status outcomes: Progression of dental caries in the permanent dentition, assessed via tooth decay increment: DMFS (Decayed, Missing, Filling, Surface) and/or DMFT scores; filled teeth including replaced restorations; early carious lesions which are arrested or reversed; root caries.

Information sources

- The Cochrane database including: Oral Health Group's Trials Register (2015),
- MEDLINE (from 1966 to September 2015),
- EMBASE (from 1980 to September 2015),
- PsycINFO (from 1966 to September 2015).

The search included reference lists from relevant articles and the eligible authors of trials were contacted for additional information if necessary. The search was not restricted to a particular language.

Search

A detailed search strategy was developed from Medline. An information specialist was consulted to assist with the development of the search strategy, as previous research suggests this improves the quality of the search [22]. This search strategy was amended accordingly for use on each of the other selected databases. MeSH (fixed vocabulary) and free text terms will be used to conduct the search strategy. Additional file 1 lists the search terms, which were adopted.

Study selection

Two authors (S Al and JTN) conducted the search and assessed the studies, initially through evaluating titles, keywords, and abstracts. Any articles, which were not considered to be suitable, were rejected at this stage. Full reports of studies were retrieved for all studies if they met the inclusion criteria. Further full review was conducted if the studies met the inclusion criteria for full assessment.

Data collection process

Data were collected for each study on a data sheet, which includes the following data points:

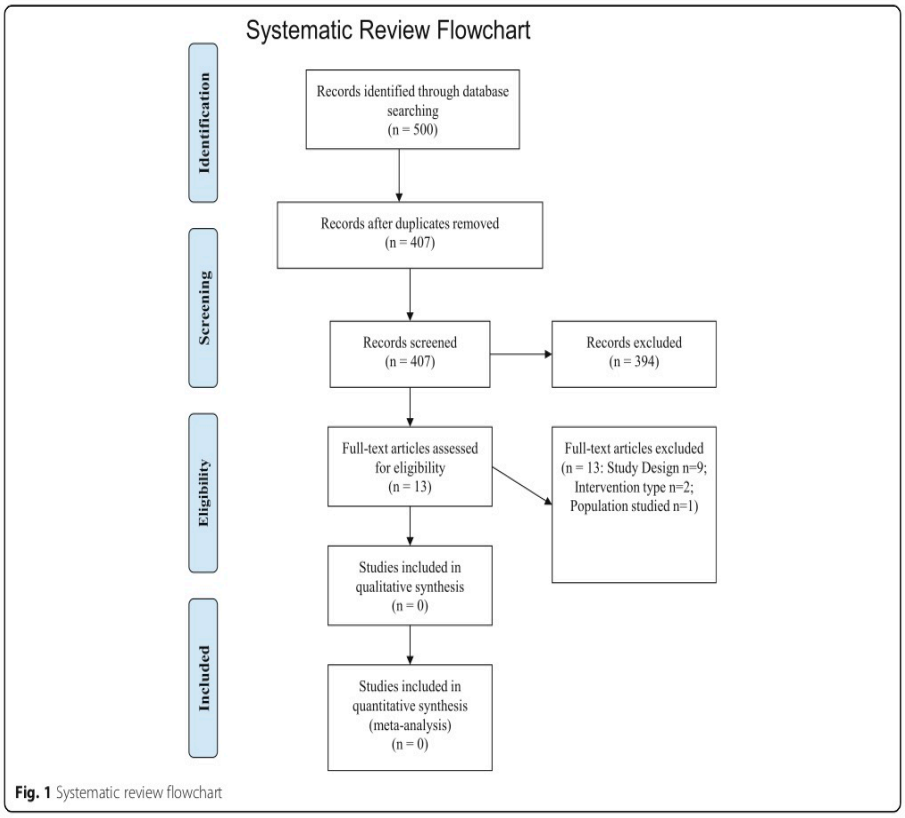

Fig. 1 Systematic review flowchart

- Study Design
- Sample size
- Psychological constructs assessed and theoretical framework adopted
- Measures of primary and secondary outcomes
- Effect of intervention on outcomes

Two authors (JTN and SAL independently extracted the data, following the guidance of the Cochrane reviewers' handbook checklist [22].

Table 1 Characteristics of excluded studies

Reference	Paper Title	Participants	Study Design	Psychological Model	Reasons for exclusion
Reisine et al. (1994) [27]	A biopsychosocial model to predict caries in preschool children	Children & parents	Cross-sectional survey	None specified	Cross-sectional study
Astrøm & Rise (1996) [28]	Analysis of adolescents' beliefs about the outcome of using dental floss and drinking non-sugared mineral water.	Adolescents	Cross-sectional survey	None specified	Cross-sectional study and participants were adolescents
Astrøm, Awadia & Bjorvatn (1999) [29]	Perceptions of susceptibility to oral health hazards: a study of women in different cultures.	Adults	Cross-sectional survey	None specified	Cross-sectional study
Roberts, Blinkhorn & Duxbury (2003) [30]	The power of children over adults when obtaining sweet snacks.	Children & parents	Cross-sectional survey	Theory of Reasoned Action	Cross-sectional study
Adair et al. (2004) [31]	Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economically diverse groups.	Children	Cross-sectional survey	Theory of Planned Behaviour, Health Belief Model andthe Health Locus of Control	Cross-sectional study and participants were children
Astrom (2004) [32]	Validity of Cognitive Predictors of Adolescent Sugar Snack Consumption.	Adolescents	Cross-sectional survey	Theory of planned behaviour	Cross-sectional study and participants were adolescents.
Astrøm AN, & Okullo I., (2004) [33]	Temporal stability of the theory of planned behavior: a prospective analysis of sugar consumption among Ugandan adolescents.	Adolescents	Cross-sectional survey	Theory of planned behaviour	Cross-sectional study
Skeie et al., (2006) [34]	Parental risk attitudes and caries-related behaviours among immigrant and western native children in Oslo.	Children & parents	Cross-sectional survey	Theory of planned behaviour, Sociallearning theory and the Health Belief Model. Health Locus of Control	Cross-sectional study
Astrøm & Kiwanuka (2006) [35]	Examining intention to control preschool children's sugar snacking: a study of carers in Uganda.	Children	Cross-sectional survey	Theory of planned behaviour	Cross-sectional study and participants were children
Vanagas et al. (2009) [36]	Associations between parental skills and their attitudes toward importance to develop good oral hygiene skills in their children.	Adults	Cross-sectional survey	Theory of Planned Behaviour, Health Belief Model and the Health Locus of Control model,	Cross-sectional study
Tolvanen et al. (2009) [37]	Changes in children's oral health-related behavior, knowledge and attitudes during a 3.4-yr. randomized clinical trial and oral health-promotion program.	Children	RCT	None specified	Participants were children and no Social Cognition Models identified
Harris et al. (2012) [24]	One-to-one dietary interventions undertaken in a dental setting to change dietary behaviour.	All ages	Systematic Review (S.R)	None specified	No Social Cognition Models identified
Weber-Gasparoni et al. (2013) [38]	An effective psychoeducational intervention for early childhood caries prevention: part 1	Children & parents	RCT	Self-determination theory (SDT)	Participants were children
Weber-Gasparoni et al. (2013) [39]	An effective psychoeducational intervention for early childhood caries prevention: part 2	Children & parents	RCT	Self-determination theory (SDT)	Participants were children

Risk of bias in individual studies

The Cochrane reviewers' handbook checklist was to be used [23] to assess the risk of bias interventional trials.

Synthesis of data

A meta-analysis was planned if a sufficient number of homogeneous studies met the inclusion criteria.

Results

Description of studies

Initially, the search strategy identified 500 articles (see Fig. 1- Systematic Review Flowchart). After exclusion of duplicates, the titles and abstracts of 407 articles were screened for relevance. At this stage 13 papers were apparently relevant being related to dentistry and having applied psychological models and theories to develop the reported intervention. However, after obtaining the full manuscripts no article met the full eligibility criteria for the current systematic review. Table 1 provides the characteristics of the excluded studies.

Risk of bias and data synthesis

Given that there were no papers meeting the criteria for the review, risk of bias and synthesis of data were not conducted.

Discussion

This review sought to assess the effectiveness of interventions based on social cognition models (SCMs) to reduce sugar consumption among adults. The review focused on an often neglected area of health psychology that of oral health. No studies were found that matched the inclusion criteria of the review.

There is a dearth of intervention studies designed to explore the effectiveness of psychologically based interventions on oral health including oral hygiene as well as diet related behaviour. Harris and his colleagues [24] examined the effectiveness of one-to-one dietary interventions for dietary behavior among all age groups in dental settings. They identified five studies, none of which included the modification of constructs identified from psychological models of behaviour. Similarly Renz et al. [10], Werner et al. [25] and Newton and Asimakopoulou [11] located very few trials of interventions to enhance oral health related behaviours (toothbrushing and flossing) based on psychological theory, echoing calls for more and better-designed trials [26].

Whilst it is disappointing that no intervention studies based on psychological theoretical models were identified from our systematic search, the current review has confirmed the need for high quality, theory-driven interventions to support clinical practice and has highlighted potential opportunities for researchers and intervention designers to explore and examine such approaches.

Conclusion

To date there has been no published study of the effectiveness of interventions based on Social Cognition Models (SCMs) aimed at reducing sugar intake related to dental caries among adults. Given the contribution of dietary sugars to caries development and the role of lifestyle change to combat dietary sugar intake, there is a need for trials of theory-based interventions aimed at reducing individuals' consumption of dietary sugars.

Additional file

Additional file 1: Keywords search strategy. (DOCX 123 kb)

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Authors' contributions

ARS, KA and JTN contributed to conception and design of the study. ARS, KA and JTN contributed to acquisition, analysis, or interpretation of the data. ARS drafted the manuscript. KA and JTN critically revised the manuscript. ARS, KA and JTN gave final approval. ARS, KA and JTN agree to be accountable for all aspects of work ensuring integrity and accuracy. All authors read and approved the final manuscript.

Ethics approval and consent to participate

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Competing interests

The authors declare that they have no competing interests.

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ARTICLE OPEN

Factors related to reducing free sugar intake among white ethnic adults in the UK: a qualitative study

Said Harith Al Rawahi, Koula Asimakopoulou and Jonathon Timothy Newton

OBJECTIVE/AIMS: To determine the barriers and enablers to behavioural change to reduce free sugar intake related to dental caries in a sample of UK adults who identify their ethnicity as White.
MATERIALS AND METHODS: Qualitative study comprising semi-structured interviews of 27 participants. Interviews were recorded, transcribed and analysed using thematic analysis methods. The Capability-Opportunity-Motivation-Behaviour model (COM-B) and the Theoretical Domains Framework (TDF) were used to guide the derivation of themes.
RESULTS: Data saturation occurred at 27 interviews. The COM-B Model and TDF domains captured various factors that may influence the consumption of free sugar. TDF elements which are reflected in the study are: Knowledge; Psychological skills; Memory, attention, and decision processes; Behavioural regulation; Physical skills; Social influence; Environmental context and resources; Social and professional role and identity; Beliefs about capabilities; Beliefs about consequence; Intentions and goals reinforcement; and Emotions. COM-B Model elements which are reflected in the study are: psychological capabilities, physical capabilities, social opportunities, physical opportunities, reflective motivation, and automatic motivation.
DISCUSSION AND CONCLUSION: The COM-B model and TDF framework provided a comprehensive account of the barriers and facilitators of reducing sugar intake among white ethnic groups.

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INTRODUCTION

Sugar intake of >10% of the total energy intake per day can lead to a high level of dental caries[1–3] even with exposure to fluoride.[1,2,4] Therefore, the World Health Organisation published new guidelines recently for free sugar intake in both adults and children,[5] and suggested the following recommendations:

- a reduction in free sugar intake during the lifespan of individuals,
- a reduction in free sugar intake to <10% of the total energy intake for both adults and children, and
- a conditional recommendation of a further reduction in free sugar intake to <5% of the total energy intake in these populations.

A daily free sugar intake of <10% of the total energy intake reduces the prevalence of dental caries, and a further reduction in free sugar intake to <5% will even further decrease the risk of dental caries.[1,6] In addition, based on ecological studies, free sugar intake of <5% of the total energy consumed will also prevent the progression of dental caries long-term.[1] Free sugar intake of 5% of the total energy consumed is equivalent to 7–8 teaspoons (35 g) of sugar for men and 5–6 teaspoons (25 g) for women.[7]

The rate of free sugar intake among adults in the UK, however, is consistently higher than the WHO recommendation. According to the National Diet and Nutrition Survey UK,[8] the free sugar intake among adults aged 19–64 years old is 12.1% of the total energy intake, and the free sugar intake for those over 65 years is 11.5% of the total energy intake. In addition, the free sugar intake of most ethnic groups in the UK exceeds the goal of <5% of total energy intake; however, the Defra report[9–15] indicates that people who identify their ethnicity as White have the highest free sugar intake compared with other ethnic groups in the UK.

Many studies have reported on the factors that contribute to the intake of free sugar, including environmental and context, psychological, physical and social factors. Examples of environmental and context factors include: sources of sugar, prices, food content, availability, accessibility and the advertising of sugary foods, low household income; cultural commitments.[16–24] Examples of psychological factors include the perception of sugary beverages; individual choice; knowledge level. Examples of physical factors are the intake of fast food and being passive, e.g., watching TV for long period.[17,18,20,21,23–25] Finally an example of social factor is parental control practices.[20]

In addition, there have been several suggestions for interventions to reduce sugar intake including deliver shocking educational messages,[17] reducing the availability of beverages,[19] educational strategies for both children and parents and develop a policy at both the government and school levels to reduce the intake of beverages.[20]

A recent survey conducted in Europe sought to identity consumers' attitudes towards healthy eating.[26] The participants included 2500 adults (males and females) aged 18–75 years old from five European counties, including the UK. The survey identified factors, such as monitoring sugary food intake, searching for foods with low sugar, individuals' perceptions about artificial sweeteners, and their influence on the choice of buying, as factors related to sugar intake.[26] While this report highlighted some of the factors that need to be understood in order to encourage individuals to make healthy choices in relation to their sugar intake, the published report did not include details about

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how the research was conducted, nor how the variables that influence sugar intake were identified.

Much of the previous research in this area has not been informed by a theoretical framework of behaviour change, which is essential in the design of effective behaviour change strategies.[27–30] Interventions based on such models have been shown to be more effective than non-theory based interventions.[31] Behaviour change theories and models, such as the theory of planned behaviour and social cognitive theory, have been developed to understand behaviours and achieve behavioural change.[32] In many cases, however, these theories and models of behavioural change have failed to facilitate change due to major limitations, such as a lack of focus on the circumstances of how a behaviour occurs or a lack of coherence.[33,34] In contrast, more recently a new model known as the capability-opportunity-motivation-behaviour (COM-B) model has been proposed. The COM-B model aims to understand or analyse behaviours and provide a 'behavioural diagnosis'.[34] According to the COM-B model, an individual's behaviour is the result of an interaction between three main conditions: the individual's capability to perform the behaviour, the opportunity that facilitates the behaviour, and the motivation that promotes the behaviour at a given moment.[34–36] The Theoretical Domains Framework (TDF) is a system that consists of 14 domains (constructs) that can be used along with the COM-B model for further analysis of behaviour.[37] Both models can be used in conjunction to analyse factors that enhance or prevent the practice of any behaviour.[32] Both frameworks have been used in different fields related to health including: assessing barriers and enablers to delivery of the Healthy Kids Check;[38] assessing barriers of doctors toward appropriate prescription of older hospitalised patients;[39] and development of resource linkage and an IT-enabled health coaching program for disadvantaged Latina moms with recent gestational diabetes.[40] In these studies, the TDF framework and COM-B Model, have shown to be useful tools in diagnosing behaviour (e.g., identifying barriers and facilitators) and developing interventions that meet the need of individuals in the society.

To date, no studies have employed the COM-B model and/ or TDF to understand the barriers and facilitating factors to the reduction of the intake of free sugar to $<5\%$ of the total energy intake among White ethnic adults in the UK. To achieve this a qualitative descriptive method was adopted that provides an in-depth identification of facilitating factors and barriers related to the reduction of free sugar intake to $<5\%$ of the total energy intake among White ethnic adults in the UK.

RESEARCH QUESTION

What are the potential barriers and facilitators to behavioural change to reduce free sugar intake related to dental caries in a sample of UK adults who identify their ethnicity as White.?

MATERIALS AND METHODS

Qualitative data were collected through a series of semi-structured interviews[41] which were then analysed using Thematic analysis.[42]

Sample

The sample comprised White ethnic adults aged 18 and over.

For the purposes of this study, the White ethnic adults invited to take part were those individuals who live in the UK, spoke English, and identified themselves as White.

The sample frame for this study was based on the 'flow population' method, which involves a process where samples are purposefully selected from a particular site or setting.[43] In this study, the sample frame was the staff and students of King's College London, because this location was more practical than other sites in terms of accessibility. Also, students and staff are from different White ethnic background in the UK, possibly leading to a varied sample population.

For this study, purposive sampling was used as the aim of the study is associated with particular ethnicity and age. For purposive sampling in this study, maximum variation and snowballing methods were used, as these methods allow sampling of participants or individuals based on the selection criteria but in a widely varied manner.[43] The selection of the purposive sampling is based on age and ethnicity criteria.

Participants were recruited through King's College London based on the sample criteria. Participants who voluntarily agreed to take part in the study were asked to sign the consent form and fill out an application describing their demographic data. In addition, participants were contacted through email and telephone to provide further details about the study and to arrange an interview appointment.

Procedure and data collection

A topic guide was used to guide the interviews. The objectives of the interviews were provided to each participant at the beginning of each session. Privacy and anonymity was emphasised at the commencement of the interviews. The duration of the interviews ranged from 15 to 90 min. One interviewer conducted all of the interviews, which were audio recorded. Participants were informed about the interview taping both in the consent form and before commencing the interview.

The questions were developed based on established guidelines[36] and mapped to the COM-B and TDF elements.

Ethical approval

The study was approved by the King's College London Research Ethics Committee Reference: LRS15/16 2651. All participants provided written informed consent.

Monetary rewards

An Amazon voucher valued at £20 was given to participants in appreciation of their time after the interview. The purpose of incentives is to encourage the participants to contribute to the study.

Data analysis

The data were analysed thematically[42] based on the categories/themes of the TDF and COM-B model. First, the audio file for each interview was imported into the MAXQDA 12 qualitative analysis software for analysis. Second, a theme guide was developed from the already published definitions of the constructs related to the TDF domains and COM-B model elements. In addition, a general criterion related to sugar intake was considered before codes were collated under the themes of TDF. This stage helped to assign all the themes with factors related to sugar intake. Third, after import of the audio files, each file was converted to a transcript for review by the interviewer (SHAR) to ensure consistency of the transcripts with the audio files. A second investigator (JTN) then reviewed a subsample of transcripts and was in agreement with the interviewer. Fourth, excerpts from the transcripts were coded, and relevant codes were collated under a single subtheme and each subtheme was defined. Fifth, each subtheme was mapped to a domain of the TDF. Sixth, the codes, subthemes, and themes were reviewed three times to ensure the validity of the content of each theme. Review of the coding again took place during the mapping and writing stages.

RESULTS

Characteristics of participants

Data saturation occurred at 27 participants. Most were from English, British, Irish, Scottish, and other White ethnic groups. These different categories of white ethnicity are based on ethnicity classifications of Office for National Statistics, UK.[44] A similar number of males and females and of staff and students were included. Table 1 presents the detailed characteristics of the participants.

Barriers and facilitating factors

The factors that were reported to influence the sugar intake fitted well within the framework of the TDF themes. No comments could be coded to the TDF Optimism theme, which is associated with the Automatic and Reflection elements of COM-B. The following sections describe some of the facilitators and barriers identified in each theme. Please refer to SupplementaryInformation 2 for more list of barriers and facilitators to reduce free sugar intake among the white ethnic group in the UK.

Psychological capabilities

Knowledge. In the context of this study, knowledge can be seen as both a facilitator and a barrier to change in terms of sugar intake behaviour. For example, awareness of healthy and unhealthy foods, including drinks and acidic foods, which can cause caries, as well as awareness of the amount of sugar in food and the time to eat sweets can help to increase the possibility of reducing sugar intake. Please refer to quotes number 1–2 in Supplementary Information 1.

However, knowledge can be act as barrier to reduce sugar intake. For example lack of knowledge about the term free sugar and sugar and lack of understanding of the recommended free sugar intake per day. Please refer to quotes number 3-4 in Supplementary Information 1.

Psychological skills. The psychological skills identified in this study included the ability to calculate the amount of sugar consumed per day, interpreting the labelling of foods, and assessing the sugar content of foods or meals. Please refer to quotes number 5–6 in Supplementary Information 1.

However, some of the participants stated that they do not perform sugar assessment when they eat meals. This can act as a barrier towards reducing free sugar intake. Please refer to quote number 7 in Supplementary Information 1.

Memory, attention, and decision processes

Memory, attention, and decision processes include remembering sugar intake advice and the amount of sugar in foods or meals and choosing food with lower sugar or natural sugar increases the possibility of reducing free sugar intake. Please refer to quotes number 8, 9, 10 in Supplementary Information 1.

In contrast, memory, attention, and decision processes can also act as barriers towards change. For example, some participants indicated that they do not pay attention to or are less focused on sugar intake and identifying sugar content in foods. Instead, attention is paid to food that has been reduced in price or is part of a special offer. Also, some of these participants indicated that when they eat sweet food they think of their body weight rather than their teeth and other participants indicated that they prioritise taste over health. Moreover, some of the participants prioritise frequency of eating free sugar over the amount of free sugar and other participants choose food with low calories instead of food low free sugar. In addition, some of the participants raised concerns about their trust of the labelling system and stating that these concerns influence their decision process to reduce sugar intake. Please refer to quotes number 11–19 in Supplementary Information 1.

Table 1. Characteristics of participants

Characteristics	*Frequency*
Gender	
Female	16
Male	11
Job title	
Staff	14
Student	13
White Ethnicity	
Scottish	1
English	10
British	7
Irish	1
Others	8
Age	Ranged from 19 to 59 years old

Behavioural regulation

Behavioural regulation factors play an important role in minimising sugar intake. Setting of an action plan for daily sugar intake, selecting small size portions of sweets, and prioritising fresh food can help in reducing sugar intake. Please refer to quotes number 20–21 in Supplementary One. Some participants said that they think first their body weight and fitness then dental health. Also, considering food calories first then other element of food labelling can act as a barrier, because not all low calorie food has low sugar. Please refer to quotes number 22–23 in Supplementary Information 1.

Physical capabilities

Physical skills. Such skills include the selection of cheap and healthy foods, selection of small portions of sweets, cooking/preparing healthy food, not adding sugar to foods or drinks, and the ability to determine the sugar content on food labels. Please refer to quotes number 24–26 in Supplementary Information 1.

However, some of the participants stated that they add sugar in food. Please refer to quotes number 27 in Supplementary Information 1.

Social opportunities

Social influence. Parents and friends offer both positive support for the reduction of sugar consumption and a possible negative influence. The participants indicated that parents, for example, can limit the purchase of sweets or sugary foods. Also, trusted members of the family or society can encourage individuals to consume less sugar. Please refer to quotes number 28–29 in Supplementary Information 1.

In contrast, family members and friends may encourage the purchase of sweets or unhealthy food. Also, individuals can be influenced by a friend's health condition. Please refer to quotes number 30–31 in Supplementary Information 1.

Physical opportunities

Environmental context and resources. The environmental context and resources have a major influence on the consumption of free sugar. The cost of food may promote the consumption of cheap high sugar content foods. Also, the participants stated that social media can promote healthy food choices. Please refer to quotes number 32–33 in Supplementary Information 1. Participants raised many concerns about the fact that environmental context and resources can increases the consumption of free sugar. Many perceived there to be limited access to healthy food outside the home particularly snack foods. Also, participants voiced concern that healthy foods are expensive, and many low-income families have limited money for food. Advertisements and promotions can also contribute to an increase in sugar consumption. Please refer to quotes number 34–36 in Supplementary Information 1.

Reflective motivation

Social and professional role and identity. Social and professional identities including part experiences, can play an important role in

influencing sugar intake. Please refer to quotes number 37–38 in Information 1.

However, some participants stated that identities inherited from their parents and culture can increase the consumption of sugar. Also, an individual who was a student or on low-income may buy cheaper unhealthy foods. Please refer to quotes number 39–40 in Supplementary Information 1.

Beliefs about capabilities. A belief in your own ability to cook food, that it is easy to identify the amount of sugar in foods, that one is able to quantify sugar intake, that one is able to know sugar content by labels, that sugar content can be found on packaging, and that one can calculate the amount of sugar consumed per day can contribute to the reduction of free sugar intake. Please refer to quotes number 41–42 in Supplementary Information 1.

In contrast, if the beliefs about individual capabilities are weak or the individual is less confident, these beliefs can easily prevent behaviour change to reduce sugar intake. The following are examples of beliefs that were mentioned by the participants during the interviews: the difficulty of controlling sugar consumption or reducing sugar intake, feeling unable to reduce sweet snacks, the ease of getting sweets, laziness, hard to know the sugar content of meals, difficult to control the influence of advertisements, difficult or impossible to read the labels, and unable to understand the labels. Please refer to quotes number 43–47 in Supplementary Information 1.

Beliefs about consequence. Examples of beliefs about the consequences of sugar intake that will facilitate the reduction in free sugar consumption include the beliefs that sweets have unhealthy consequences and that naturally occurring sugars in fruits and vegetables and cooking food have healthy consequences. Also, the participants believed that placing a picture of tooth decay on food packaging would help them to reduce sugar intake and ultimately would prevent the need for dental treatment. Please refer to quotes number 48–50 in Supplementary Information 1.

In contrast, the following examples of such beliefs were expressed by the participants act as a barrier to reduce free sugar intake: the belief that exercise alone is sufficient to control weight without a reduction in food intake, the belief that performing exercise to burn energy means that the individual can eat sugary snacks, the belief that fizzy drinks boost energy. In addition, the selection of food with low calorie content can easily prevent behaviour change to reduce sugar intake. Please refer to quotes number 51–53 in Supplementary Information 1.

Intentions and goals. Examples of intentions that were expressed by the participants include the intention not to buy sugary foods, to reduce sugar intake; to eat healthy food, and to exercise. The participants indicated that their goals were to improve their fitness level and to reduce body weight. Please refer to quotes number 54–56 in Supplementary Information 1. None of the participants stated that they had an intention or aim to maintain their teeth by reducing sugar intake. Please refer to quotes number 57–58 in Supplementary Information 1.

Automatic motivation

Social and professional role and identity. Social and professional roles and identities may influence free sugar intake unconsciously through automatic processes and choices. Routine cooking habits and parents' modelling of cooking meals consisting of low-sugar foods can promote the reduction of free sugar intake to $<5\%$ of the total energy intake. Please refer to quotes number 59–60 in Supplementary Information 1.

However, habits can act as barriers toward reduce for sugar intake. For instance, the habit of sharing food with others and annual holidays can also increase the risk of consuming more sugar. Please refer to quotes number 61–62 in Supplementary Information 1.

Reinforcement. Reinforcement is thought to have a crucial role in facilitating reduced sugar intake. In the context of this study, reinforcement was associated with interventions as a facilitator of reduced free sugar consumption. Colour-coded labelling reinforces the selection of healthy food. Another example of positive reinforcement is the perceived reward of burning off energy through exercise and education about the effects of sugar reinforcing decisions about healthy food selection. Please refer to quotes number 64–65 in Supplementary Information 1.

Emotions. Participants reported both negative and positive emotions associated with the consumption of sweet foods, for example feelings of guilt after eating sweets, enjoying the taste of fruits and drinks without artificial sugar, love of having fruits with a main meal or as a snack, and dislike of sugary foods. Please refer to quotes number 66–67 in Supplementary Information 1.

In contrast, emotions can also drive individuals towards increased sugar consumption, serving as a strong barrier towards behaviour change. The following are examples of emotions that can prevent reduction of sugar intake to $<5\%$ of the total energy intake: cravings for fizzy drinks and sweets, love of Coca-Cola, enjoyment of tasty foods, consideration of sweets as treats, the love of a bargain, and no interest in counting sugars in foods. Please refer to quotes number 68–71 in Supplementary Information 1.

In Summary, 12 TDF elements are identified as being relevant to reducing free sugar intake to $<5\%$ of the total energy: Knowledge; Psychological Skills; Memory, Attention, and Decision Processes; Behavioural Regulation; Physical Skills; Social influence; Environmental context and resources; Social and professional role and identity; Beliefs about Capabilities; Beliefs about Consequence; Intentions and Goals; Reinforcement; and Emotions. Six of the COM-B Model elements which are relevant to reducing free sugar intake to $<5\%$ of the total energy: Psychological capabilities Physical capabilities Social Opportunities Physical Opportunities; Reflective Motivation; and Automatic Motivation.

DISCUSSION

The aim of this study was to explore the barriers and enablers to behavioural change to reduce free sugar intake related to dental caries in a sample of UK adults who identify their ethnicity as White. The findings from the study indicated that the COM-B model and the TDF domains provided a comprehensive framework for the description of the facilitators of and barriers to behaviour change to reducing sugar intake. This has been reported by other studies in different fields.[38–40] This comprehensiveness of the COM-B model and the TDF domains has enabled the research to capture more factors related to free sugar intake than have been reported by previous studies.[16–25] The factors are related to the following domains of TDF: Knowledge; Psychological Skills; Memory, Attention, and Decision Processes; Behavioural Regulation; Physical Skills; Social influence; Environmental context and resources; Social and professional role and identity; Beliefs about Capabilities; Beliefs about Consequence; Intentions and Goals; Reinforcement; and Emotions. From all 14 domains of TDF, the only exception to the framework, was that none of the participants' comments could be mapped to the Optimism theme of Motivation. Altogether, these findings clearly indicated that the six elements of the COM-B model and the 14 domains of the TDF are relevant to behaviour change to reduce sugar intake.

In this study there were some limitations. one of the anticipated limitations in the study was the possible recruitment of participants from a middle-class academic setting only and that

these participants would have little or no caries. Such a population would not reflect the full social range of the White ethnic groups in the UK, though some of the student participants reported coming from the lower social classes. Another limitation was that the authors were unable to assess the sugar content of the participants' daily meals, as the brands and types of food were not verified in most of the cases. Despite these limitations, we conclude that this study highlighted many crucial factors that influence sugar intake in this population.

CONCLUSION

The COM-B model and TDF framework provided an inclusive account of the barriers and facilitators of reducing sugar intake among white ethnic groups. Although the study had some limitations, we believe that the COM-B model and TDF can be useful for the development of strategies to address specific facilitators and barriers of the implementation of interventions that aim to reduce sugar intake to $< 5\%$ of the total energy intake in relation to dental caries.

ACKNOWLEDGEMENTS

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COMPETING INTERESTS

The authors declare no conflict of interest.

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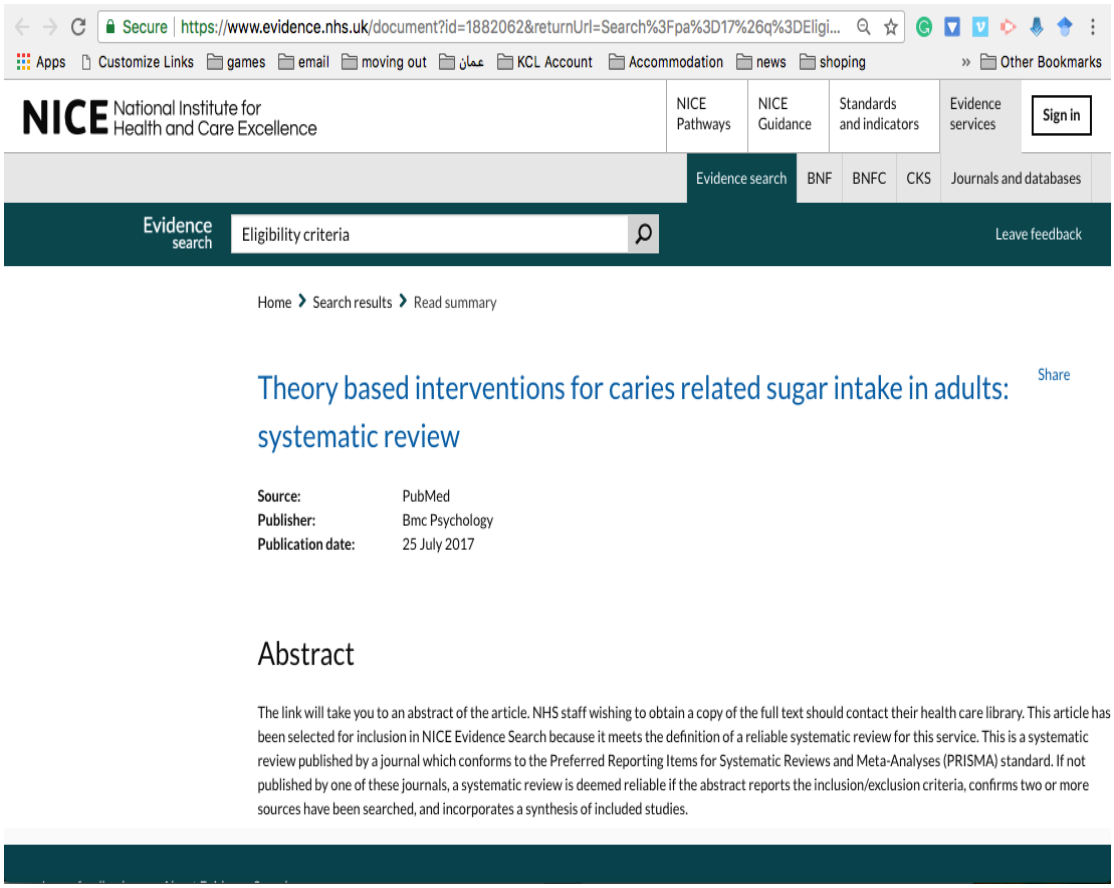
Supplementary Information accompanies the paper on the *BDJ Open* website (http://www.nature.com/bdjopen)

13.5. List of Thesis-related Comments on Publication

13.5.1. NICE on The Systematic Review



https://www.evidence.nhs.uk/document?id=1882062&returnUrl=Search%3Fpa%3D17%26q%3DEligibility%2Bcriteria%26s%3DDate&q=Eligibility+criteria

13.5.2. Almetric Score on The Systematic Review

Share

Theory based interventions for caries related sugar intake in adults: systematic review

Overview of attention for article published in BMC Psychology, July 2017

SUMMARY

Title	Theory based interventions for caries related sugar intake in adults: systematic review
Published in	BMC Psychology, July 2017
DOI	10.1186/s40359-017-0194-z
Pubmed ID	28743291
Authors	Said Hartih Al Rawahi, Koula Asimakopoulou, Jonathon Timothy Newton, Al Rawahi, Said Hartih... [show]
Abstract	Theories of behavior change are essential in the design of effective behaviour change strategies... [show]

About this Attention Score

Average Attention Score compared to outputs of the same age

Mentioned by

4 tweeters

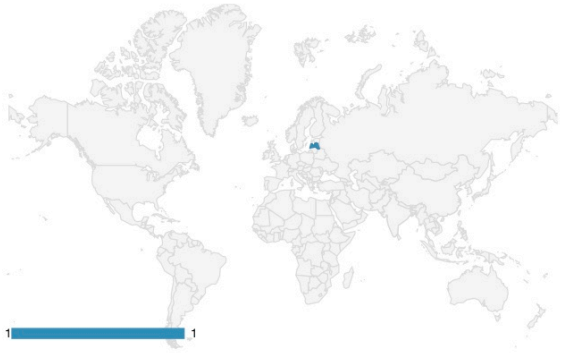
Readers on

2 Mendeley

What is this page?

Twitter Demographics

The data shown below were collected from the profiles of **4** tweeters who shared this research output. Click here to find out more about how the information was compiled.



Geographical breakdown

Country	Count	As %
Latvia	1	25%
Unknown	3	75%

Demographic breakdown

Type	Count	As %
Members of the public	2	50%
Scientists	1	25%
Science communicators (journalists, bloggers, editors)	1	25%

Mendeley readers

The data shown below were compiled from readership statistics for **2** Mendeley readers of this research output. Click here to see the associated Mendeley record.

13.5.3. BDJ Open on the Qualitative study

BDJ Open - BDJOPEN-00340 Accept

bdjopen@nature.com

Mon 11/12/2017 11:53

To: Al Rawahi, Said <said.al-rawahi@kcl.ac.uk>;

Manuscript Number: BDJOPEN-00340

Title: Factors Related to Reducing Free Sugar Intake Among White Ethnic Adults in the UK: A qualitative study

Authors: Said Al Rawahi, Koula Asimakopoulou, and Jonathon Newton

Dear Mr Al Rawahi,

I am very pleased to inform you that your above mentioned manuscript has now been accepted for publication in *BDJ Open*.

It us unusual to be able to accept a manuscript for publication with no revision needed. This was a very high quality submission and both our reviewers recommended that we accept it. I have attached their comments.

PLEASE READ THE FOLLOWING CAREFULLY

Licence to Publish

- The corresponding author of an accepted manuscript is required to return a completed and signed Licence to Publish open access form on behalf of all authors. Please also complete and return an Article Processing Charge form. Please visit the Guides to Author for details regarding publication fees.

All relevant forms must be returned as soon as possible via email: bdjopen@nature.com.

- Please note that your paper cannot be sent to production until we have received the completed forms.

Proofs

- Prior to typesetting, we may make minor changes to enhance clarity and to conform to *Journal's* style. We would therefore ask you to examine the proofs carefully to ensure that the sense of your text has not been inadvertently altered in any way.

Thank you very much for submitting your work to *BDJ Open*.

Yours sincerely,

Jonathan Lewney
Associate Editor
BDJ Open

This email has been sent through the Springer Nature Manuscript Tracking System NY-610A-NPG&MTS

13.5.4. Almetric score on Qualitative Study

Share

Factors related to reducing free sugar intake among white ethnic adults in the UK: a qualitative study

Overview of attention for article published in BDJ Open, February 2018

SUMMARY

Title	Factors related to reducing free sugar intake among white ethnic adults in the UK: a qualitative study
Published in	BDJ Open, February 2018
DOI	10.1038/bdjopen.2017.24
Authors	Said Harith Al Rawahi, Koula Asimakopoulou, Jonathon Timothy Newton

About this Attention Score

Above-average Attention Score compared to outputs of the same age (64th percentile)

Mentioned by

4 tweeters
1 Facebook page

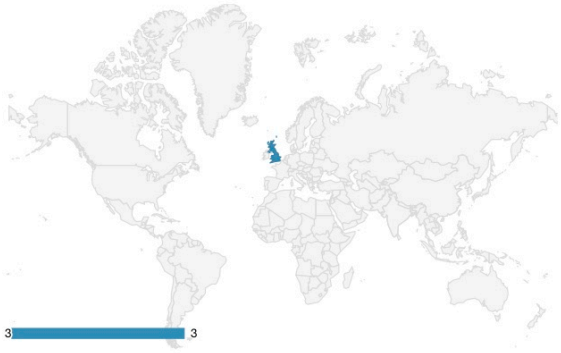
Readers on

3 Mendeley

What is this page?

Twitter Demographics

The data shown below were collected from the profiles of **4** tweeters who shared this research output. Click here to find out more about how the information was compiled.



Geographical breakdown

Country	Count	As %
United Kingdom	3	75%
Unknown	1	25%

Demographic breakdown

Type	Count	As %
Practitioners (doctors, other healthcare professionals)	2	50%
Members of the public	2	50%

Mendeley readers

The data shown below were compiled from readership statistics for **3** Mendeley readers of this research output. Click here to see the associated Mendeley record.

13.6. Supplment of the Systematic Review:

13.6.1. Search strategy for Medline, Embase, PsycINFO, Cochran Review,

A) Suggested Search Terms for Medline; PsycINFO; and Embase Classic+Embase :

1. Psychol$.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
2. Cognit$.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
3. Health belief$.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
4. Theory of planned behaviour.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
5. Theory of reasoned action.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
6. Self efficacy.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
7. Transtheoretical model.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
8. Stages of change.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
9. Locus of control.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
10. Internal-External Control.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
11. Self-regulatory model.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
12. Implementation intentions.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
13. Protection motivation.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
14. Optimistic bias.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
15. Unrealistic optimism.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
16. Health action process approach.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
17. Information Motivation Behaviour$.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
18. Information-Motivation-Behaviour$.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
19. Precaution adoption process model.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
20. Social Cognitive Theory.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
21. "Conditioning (psychology)".mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]

22. Social learning Theory.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
23. conditioning classical.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
24. Conditioning operant.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
25. (behavio$ adj 4 intention$).mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
26. (behavio$ adj4 modificat$).mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
27. (behavio$ adj4 change$).mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
28. BEHAVIOR THERAPY.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
29. COGNITIVE THERAPY.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
30. Patient education.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
31. PRIME Theory.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
32. PRIME Theory of Motivation.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
33. COM-B Model.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
34. COM-B System.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
35. Behaviour Change Wheel.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
36. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35
37. Dental caries.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
38. caries.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
39. tooth decay.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
40. caries.ab. or caries.ax. or caries.bt. or caries.ce. or caries.cf. or caries.cm. or caries.cq. or caries.cs. or caries.ct. or caries.cu. or caries.cv. or caries.dv. or caries.id. or caries.in. or caries.ja. or caries.ji. or caries.jw. or caries.jx. or caries.kf. or caries.kw. or caries.nm. or caries.nw. or caries.ot. or caries.tc. or caries.ti. or caries.tm.
41. exp tooth decay/
42. tooth decay$.mp. [mp=ti, ab, hw, tc, id, ot, tm, tn, dm, mf, dv, kw, nm, kf, px, rx, ui]
43. exp DMF/
44. 37 or 38 or 39 or 40 or 41 or 42 or 43
45. exp dietary carbohydrate/
46. carbohydrat$.ab,ti.
47. sugar$.ab,ti.

48. ((Glucose or fructose or lactose or maltose or sucrose) adj3 (diet$ or intake$)).tw.
49. sucrose/
50. exp starch/
51. Starch$.tw.
52. polysaccharide$.tw.
53. monosaccharide$.tw.
54. disaccharide$.tw.
55. oligosaccharide$.tw.
56. polysaccharides/
57. inulin$.tw.
58. inulin/
59. alginates/
60. cellulose/
61. carageenan/
62. lignin/
63. methylcellulose/
64. carboxymethylcellulose/
65. maltose/
66. mannans/
67. exp oligosaccharides/
68. pectins/
69. plant gums/
70. gum arabic/
71. karaya gum/
72. tragacanth/
73. chitin/
74. "beta glucan$".tw.
75. beta-glucans/
76. candy/
77. ((cake$ or biscuit$ or cookie$ or confectionery) adj3 (diet or intake)).tw.
78. carbonated beverages/
79. ((soda or carbonated or sweet$ or sugar$) adj3 beverage$).tw.
80. ((soda or carbonated or sweet$ or sugar$) adj3 drink$).tw.
81. "soft drink".tw.
82. 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81
83. 36 and 44 and 82

B) Suggested Search Terms for Cochrane database:

1. Psychological models or psychological Theories
2. Dental caries or tooth decay or root Caries
3. Dietary carbohydrate or dietary sugar or carbohydrate food
4. 1 And 2 AND 3

5. Behavior change models or behavior Theories
6. Dental caries or tooth decay or root Caries
7. Dietary carbohydrate or dietary sugar or carbohydrate food
8. 5 And 6 AND 7
9. Psychological Theories
10. Dental caries or tooth decay or root Caries or DMFT or DMF
11. Dietary carbohydrate or dietary sugar or carbohydrate food or sugary food
12. 9And 10 AND 11
13. Psychological Theories
14. Dental caries or tooth decay or root Caries
15. Dietary carbohydrate or dietary sugar
16. 13 And 14 AND 15
17. Psychological Theories
18. Dental caries or tooth decay
19. Dietary sugar
20. 17 And 18 AND 19
21. Psychological Theories
22. Dental caries or tooth decay
23. Adult* or mature or elder or old or geriatric*
24. 21 And 22 AND 23

13.7. Supplement of the Qualitative Study:
13.7.1. Ethical approval

Research Ethics
Office

Franklin Wilkins Building
5.9 Waterloo Bridge Wing
Waterloo Road
London SE1 9NH
Telephone 020 7848 4020/4070/4077
rec@kcl.ac.uk

KING'S College LONDON

17 May 2016

Dear Said

LRS-15/16-2651 - What influences our sugar intake? A qualitative study

I am pleased to inform you that full approval for your project has been granted by the BDM Research Ethics Panel

- Ethical approval is granted for a period of **two years** from 17 May 2016 . You will not receive a reminder that your approval is about to lapse. It is your responsibility to apply for an extension prior to the project lapsing.
- You should report any untoward events or unforeseen ethical problems to the panel Chair, via the Research Ethics Office, within a week of occurrence. Information about the panel may be accessed at: http://www.kcl.ac.uk/innovation/research/support/ethics/committees/sshl/reps/index.aspx
- If you wish to change your project or request an extension of approval, please complete and submit a Modification Request to crec-lowrisk@kcl.ac.uk. Please quote your ethics reference number, found at the top of this letter, in all correspondence with the Research Ethics Office. Details of how to complete a modification request can be found at: http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx
- All research should be conducted in accordance with the King's College London *Guidelines on Good Practice in Academic Research* available at: http://www.kcl.ac.uk/college/policyzone/assets/files/research/good%20practice%20Sept%2009%20FINAL.pdf

Please note that we may, for auditing purposes, contact you to ascertain the status of your research.

We wish you every success with your research.

Best wishes,

BDM Research Ethics Panel REP Reviewers

13.7.2. Invitation Emails from

Title of project: What influences our sugar intake? A qualitative study
study ref: [LRS15/162651], approved by [Biomedicine, Dentistry, Natural and Mathematical Sciences Research Sub-Committee].

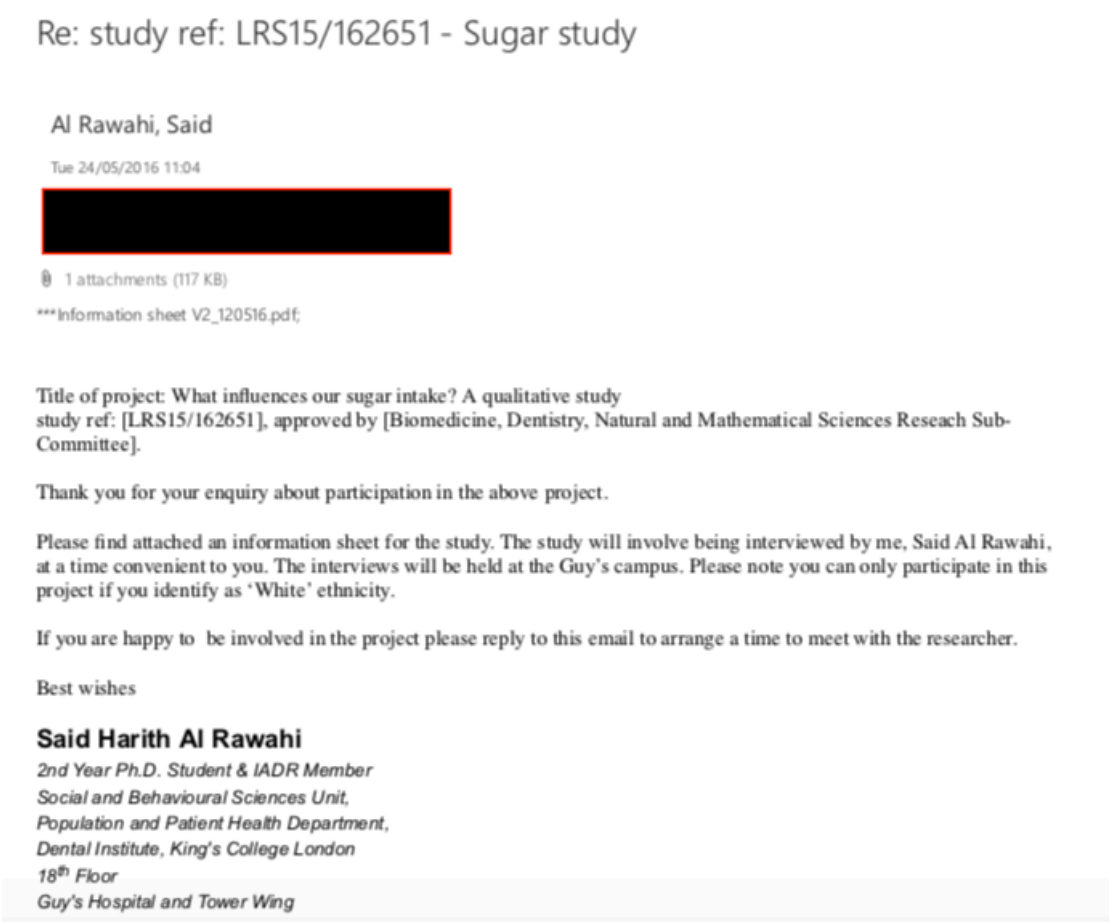
Thank you for your enquiry about participation in the above project.

Please find attached an information sheet for the study. The study will involve being interviewed by me, Said Al Rawahi, at a time convenient to you. The interviews will be held at the Guy's campus. Please note you can only participate in this project if you identify as 'White' ethnicity.

If you are happy to be involved in the project please reply to this email to arrange a time to meet with the researcher.

Best wishes

Said Al Rawahi



Re: study ref: LRS15/162651 - Sugar study

Al Rawahi, Said

Tue 24/05/2016 11:04

[redacted]

1 attachments (117 KB)

***Information sheet V2_120516.pdf;

Title of project: What influences our sugar intake? A qualitative study
study ref: [LRS15/162651], approved by [Biomedicine, Dentistry, Natural and Mathematical Sciences Reseach Sub-Committee].

Thank you for your enquiry about participation in the above project.

Please find attached an information sheet for the study. The study will involve being interviewed by me, Said Al Rawahi, at a time convenient to you. The interviews will be held at the Guy's campus. Please note you can only participate in this project if you identify as 'White' ethnicity.

If you are happy to be involved in the project please reply to this email to arrange a time to meet with the researcher.

Best wishes

Said Harith Al Rawahi
2nd Year Ph.D. Student & IADR Member
Social and Behavioural Sciences Unit,
Population and Patient Health Department,
Dental Institute, King's College London
18th Floor
Guy's Hospital and Tower Wing

13.7.3. An example of an email from interested participant for information sheet

From: [redacted]
Sent: 24 May 2016 10:03:56
To: Al Rawahi, Said
Subject: study ref: LRS15/162651 - Sugar study

Dear Said

I have just seen the mail out for this: https://internal.kcl.ac.uk/innovation/studies/dental/LRS-15-16-2651.aspx

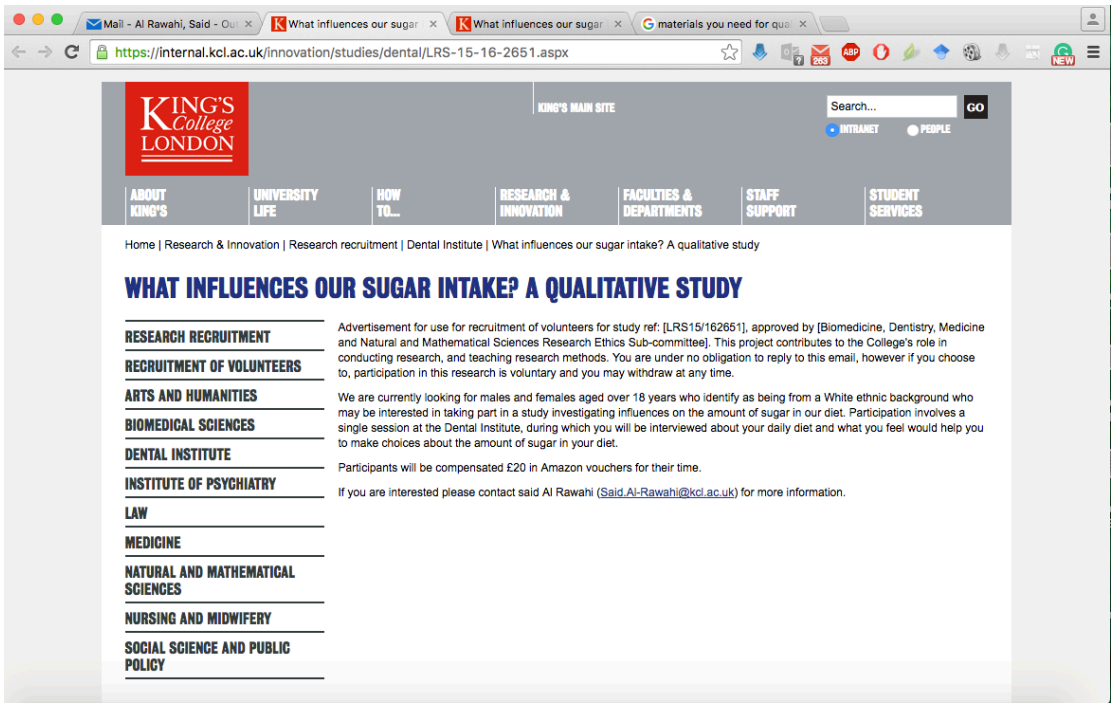
I'm a member of staff at KCL. If this is purely diet related (The mention of a dentist part sounded a bit scary! But just for talking is not) I'd be interested in taking part?

In case it's important, I'm actually a vegan [redacted] But I do enjoy "goodies" and have recently been trying to count calories/become more aware of sugar in my food. I heard somewhere that our recommended sugar intake is 6 teaspoons a day – I'd like to be within this but suspect I'm not if I looked closely!

So I'd be really interested in taking part – please let me know what details you would need from me and the time it would involve?

Best wishes,
[redacted]

13.7.4. Online Advertisement at KCL



13.7.5. Emails accepting the invitations after read the information sheet

RE: What influences our sugar intake? A qualitative study

[redacted]

Tue 24/05/2016 13:18

To:Al Rawahi, Said <said.al-rawahi@kcl.ac.uk>;

Dear Said,
I have read the attachment and would like to participate in the study.
I am based at St Thomas' and easy to come to Guys on the shuttle.
Kind regards,

[redacted]

13.7.6. Information sheet

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics Floor 18, Tower Wing

Guy's Hospital
London Bridge
SE1 9RW
Tel 020784845145
Fax 02071887486

INFORMATION SHEET FOR PARTICIPANTS

Version 2 (date 12/5/16)

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Title of study: What influences our sugar intake? A qualitative study

We are pleased to invite you to take part in a research project. It is important for you to understand the reasons why we are undertaking for this research and what will be involved before you to decide to participate or not. Please take your time to read the following information carefully. Ask us if there is anything you need to have explained more clearly and we will be more than happy to assist you.

What is the purpose of the study?

The purpose of this study is to explore the perceived facilitating factors and barriers to behaviour change in order to reduce dietary intake of free sugar to less than 5% of the total energy consumed among White adults in the UK. In particular we want to look at what influences the food you eat and what might influence people to reduce the amount of sugar in their diet..

Why have I been invited to take part?

We are asking White adults to take part. We are only asking White adults because previous research has shown that diet varies by ethnicity, and in the United Kingdom the White Ethnic group have the highest levels of sugar intake on average.

Guy's, King's St
Thomas' Dental
Institute, Department
of Orthodontics
Floor 18, Tower Wing

Guy's Hospital
London Bridge
SE1 9RW
Tel 020784845145
Fax 02071887486

Do I have to take part?

It is up to you to decide whether or not to participate. If you do decide to participate, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you agree to take part we will ask you to attend our offices at the Division of Population and Patient Health at Guy's Hospital for an interview discussion which will last up to an hour. The interview will ask about your daily diet, and how you choose and buy food.

Are there any incentives?

As recognition of the time and effort involved in participation we will offer you a £20 Amazon voucher at the end of the interview as our way of saying " Thank you".

What are the possible risks of taking part?

We believe that there are no risks or disadvantages to taking part, the only inconvenience is the time taken to answer the questions.

Will my taking part be kept confidential?

Absolutely, all information which is collected about you during the course of the research will be kept strictly confidential. The data will be protected by our University procedures. Your interview will be tape recorded and transcribed by the researcher (Said Al Rawahi). The transcript will be coded with an anonymous code known only to the research team. The information you give us will be kept on a password protected computer and the data destroyed at the end of the study. Our procedures for handling, processing, storage, and destruction of your data are compliant with the Data Protection Act 1998.

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics Floor 18, Tower Wing

Guy's Hospital London Bridge SE1 9RW Tel 020784845145 Fax 02071887486

How is the project being funded?

This project is part of Said Al Rawahi's PhD studies at King's College London.

What will happen to the results of the study?

The results will be used part of an educational qualification for Said Al Rawahi as part of his PhD studies. We also hope to publish the research in academic journals. It will not be possible for any individual participant to be identified in any publication we produce. If you would like a summary of the findings of the study let us know and we will send you a summary at the end of our data analysis.

Who should I contact for further information?

If you have any questions or require further information about this study, please contact Said Al Rawahi using the following contact details:

Said.Al-Rawahi@kcl.ac.uk

Telephone: +44 (0) 20 3 299 3481

What if I have further questions, or if something goes wrong?

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact King's College London using the details below for further advice and information:

Tim. Newton PhD, CPsychol, AFBPS, FHEA
Professor of Psychology as applied to dentistry
Unit of Social and Behavioural Sciences

Koula Asimakopoulou, PhD, CPsychol, AFBPS, FHEA
Reader in Health Psychology
HCPC Registered Health Psychologist

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics Floor 18, Tower Wing

Guy's Hospital London Bridge SE1 9RW Tel 020784845145 Fax 02071887486

King's College London
Floor 18, Tower Wing
Guy's Hospital
London SE1 9RW
+44 (0) 20 7 848 5145
Tim.newton@kcl.ac.uk

Unit of Social and Behavioural Sciences
King's College London
Floor 18, Tower Wing
Guy's Hospital
London SE1 9RW
+44 (0) 207 848 5145
koula.asimakopoulou@kcl.ac.uk

The Biomedical Sciences, Dentistry, Medicine and Natural & Mathematical Sciences Research Ethics Sub Committee (BDM RESC, Reference LRS15/162651) has approved this research. If you have any questions or complaints relating to the conduct of the research that have not been addressed satisfactorily by the research team please contact the BDM RESC (bdm@kcl.ac.uk)

Thank you for reading this information sheet and for considering taking part in this research- please ask any questions if you need to

13.7.7. Topic Guide

Topic Guide

Introduction:

"The aim of this interview is to identify your thoughts on what helps and hinders you in controlling the amount of sugar that you eat as part of your diet. Recent guidance from the World Health Organisation suggests that sugar intake should be less than 10% of total energy intake for adults (that's about 7-8 teaspoons of sugar for men and 5-6 teaspoons for women) and that preferably we should have about half that. We are hoping to use the information you give us to develop an intervention to help people change how much sugar they eat. "

Emphasise:

- Privacy of results
- Introduction digital audio recorder
- Stress confidentiality

Core Questions:

1. The recommendations talk about 'free sugar' - What do you understand by that?
2. What kind of foods do you think are bad for teeth ?
3. Tell me about the kinds of things you would eat on a usual day.
    - **b.** Prompt for different meals
        - **i.** Breakfast
        - **ii.** Lunch
        - **iii.** Dinner
    - **c.** Ask about snacks
    - **d.** Ask about drinks – any sugar or other sweetener (syrups, honey etc)
4. How do you choose what to buy when shopping for food or meals?
5. How easy do you find it to identify how much sugar is in your food or meals?
6. Is there anything in particular that influences what you buy in the way of food? Prompt for:
    - **a.** Partner shops, or shopping for partner
    - **b.** Shopping for children
    - **c.** Promotions in store

d. Illness (eg diabetes) that

e. Hobbies etc (eg sport)

f. Diet for slimming etc

7. Do you prioritize foods or menus with low sugar?
    a. If yes … why
    b. If no … why not
8. What would be the best way to help you in selecting foods or meals to meet the recommended free sugar intake? Prompt for
    a. labels or colour coding foods that are high or low in sugar. What type of label:
        i. Amount (%) of sugar in food
        ii. Colour codes
        iii. Amount of exercise to burn off energy
    b. Education about the sugar in foods
    c. Government restriction on amount of sugar in food / food tax.

Closing questions:

Would you like to add any other points?
Would you like to ask any questions?

Thanking you for participating

13.7.8. Demographic data sheet

Finally some questions about you

*(Please note, your information will **not** be sold or given or shared to outside entities. Its mainly for research purpose)*

1. How would you describe Ethnic background (Show ONS categories):

   _____

2. Gender: Female Male

3. Age

4. Have you ever had a filling on one of your teeth ?

   Yes, when was your last filling _____

   No

Ethnic Categories

(Show to participants)

Applies to all

Interviewer to read:

What is your ethnic group?

Choose one option that best describes your ethnic group or background

White

1. Scottish / English / Welsh / Northern Irish / British
2. Irish
3. Gypsy / Traveller
4. Any other White background, please describe

Mixed / Multiple ethnic groups

5. White and Black Caribbean
6. White and Black African

7. White and Asian

8. Any other Mixed / Multiple ethnic background, please describe

Asian / Asian British

9. Indian

10. Pakistani

11. Bangladeshi

12. Chinese

13. Any other Asian background, please describe

Black / African / Caribbean / Black British

14. African

15. Caribbean

16. Any other Black / African / Caribbean background, please describe

Other ethnic group

17. Arab

18. Any other ethnic group, please describe

(Office for National Statistics, 2015; P8.)

13.7.9. Consent form

Version2 – 12/05/16

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: What influences our sugar intake? A qualitative study

King's College Research Ethics Committee Ref:_ LRS15/162651

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

	Please tick or initial
I confirm that I understand that by ticking/initialling each box I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study.	☐

	Please tick or initial
1. **I confirm that I have read and understood the information sheet dated V2 – 12/05/16 for the above study. I have had the opportunity to consider the information and asked questions which have been answered satisfactorily.**	☐
2. **I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. Furthermore, I understand that I will be able to withdraw my data up to 31 July 2016.**	☐
3. **I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.**	☐
4. **I understand that my information may be subject to review by responsible individuals from the College for monitoring and audit purposes.**	☐
5. **I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications**	☐
6. **I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and**	☐

approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).

7. **I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.** ☐
8. **I consent to my interview being audio/video recorded.** ☐

_____	_____	_____
Name of Participant	**Date**	**Signature**
_____	_____	_____
Name of Researcher	**Date**	**Signature**

13.7.10. .Payment receipt slip

Guy's, King's St
Thomas' Dental
Institute, Department
of Orthodontics
Floor 18, Tower Wing

Guy's Hospital
London Bridge
SE1 9RW
Tel 02078648145
Fax 02071867486

KING'S College LONDON

I acknowledge receipt of a £20 Amazon Voucher in recognition of my contribution to the research project

What influences our sugar intake? A qualitative study

BDM RESC LRES-2651

Name

Date

Signed

13.8. Supplement of the Pilot Study

13.8.1. Ethical approval

Research Ethics Office
King's College London
Rm 5.11 FWB (Waterloo Bridge Wing)
London
SE1 9NH

14 March 2017
TO: Said Al-Rawahi
SUBJECT: Confirmation of Registration for "What influences our sugar intake? A Quantitive Study"

Dear Said

Thank you for submitting your Research Ethics Minimal Risk Registration Form. This letter acknowledges the receipt of your registration; your Research Ethics Number is **MR/16/17-325**. You may begin collecting data immediately.

Be sure to keep a record your registration number and include it in any materials associated with this research. Registration is valid for **one year** from today's date. Please note it is the responsibility of the researcher to ensure that any other permissions or approvals (i.e. R&D, gatekeepers, etc.) relevant to their research are in place, prior to conducting the research.

Record Keeping:
In addition, you are expected to keep records of your process of informed consent and the dates and relevant details of research covered by this application. For example, depending on the type of research that you are doing, you might keep:

- A record of the relevant details for public talks that you attend, the websites that visit, the interviews that you conduct
- The 'script' that you use to inform possible participants about what your research involves. This may include written information sheets, or the generic information you include in the emails you write to possible participants, or what you say to people when you approach them on the street for a survey, or the introductory material stated at the top of your on-line survey.
- Where appropriate, records of consent, e.g. copies of signed consent forms or emails where participants agree to be interviewed.

Audit:
You may be selected for an audit, to see how researchers are implementing this process. If audited, you will be expected to explain how your research abides by the general principles of ethical research. In particular, you will be expected to provide a general summary of your review of the possible risks involved in your research, as well as to provide basic research records (as above in Record Keeping) and to describe the process by which participants agreed to participate in your research.

Remember that if you have any questions about the ethical conduct of your research at any point, you should contact your supervisor, the Research Ethics office, or a member of your Department's Research Ethics Panel for advice.

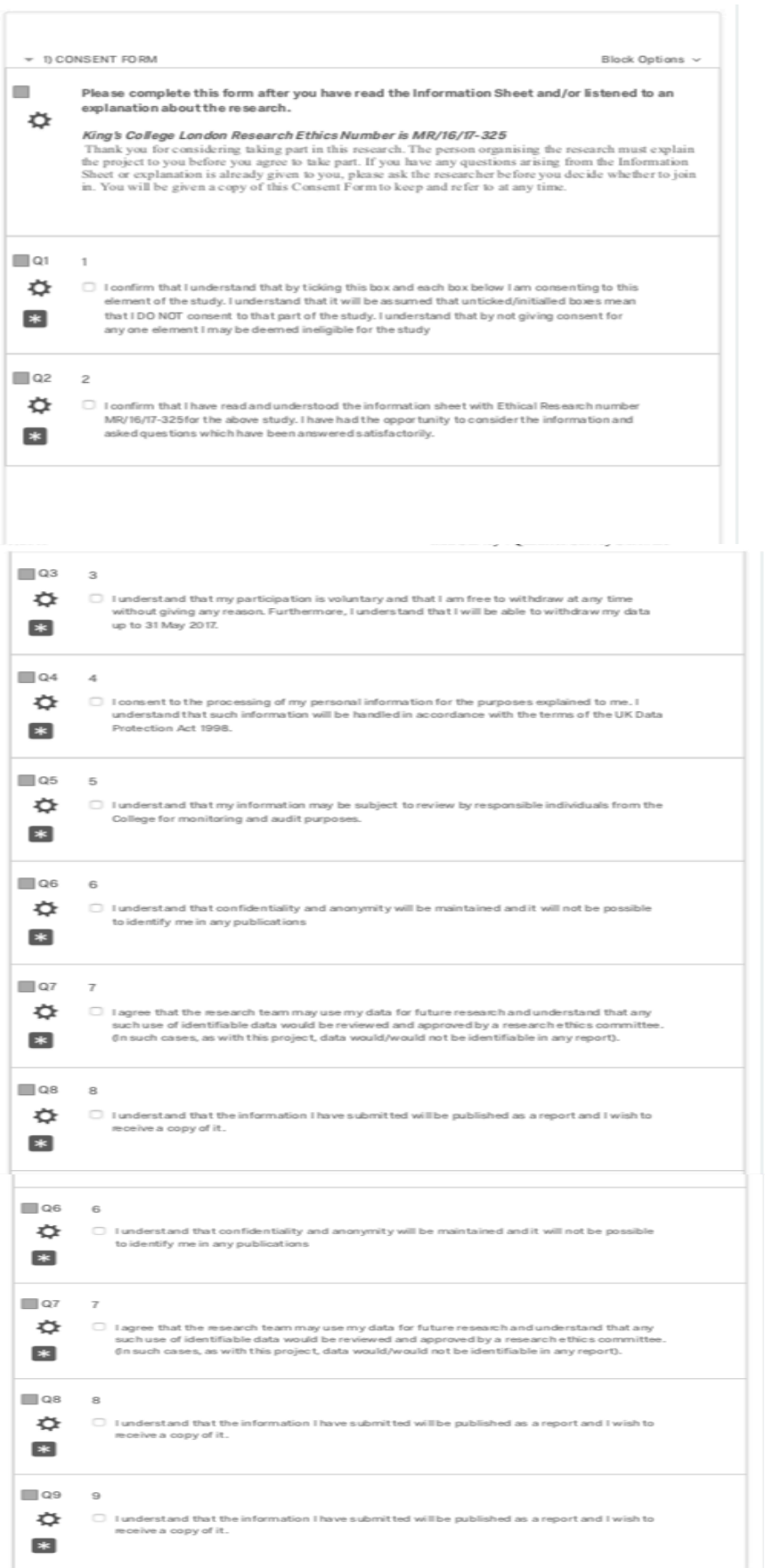
Feedback:
If you wish to provide any feedback on the process you may do so by emailing crec-minrisk@kcl.ac.uk .

We wish you every success with this work.

With best wishes

Research Ethics Office

13.8.2. Consent form


1) CONSENT FORM

Block Options

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

King's College London Research Ethics Number is MR/16/17-325

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation is already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Q1 1

I confirm that I understand that by ticking this box and each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study

Q2 2

I confirm that I have read and understood the information sheet with Ethical Research number MR/16/17-325for the above study. I have had the opportunity to consider the information and asked questions which have been answered satisfactorily.

Q3 3

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. Furthermore, I understand that I will be able to withdraw my data up to 31 May 2017.

Q4 4

I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.

Q5 5

I understand that my information may be subject to review by responsible individuals from the College for monitoring and audit purposes.

Q6 6

I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications

Q7 7

I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).

Q8 8

I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.

Q6 6

I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications

Q7 7

I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).

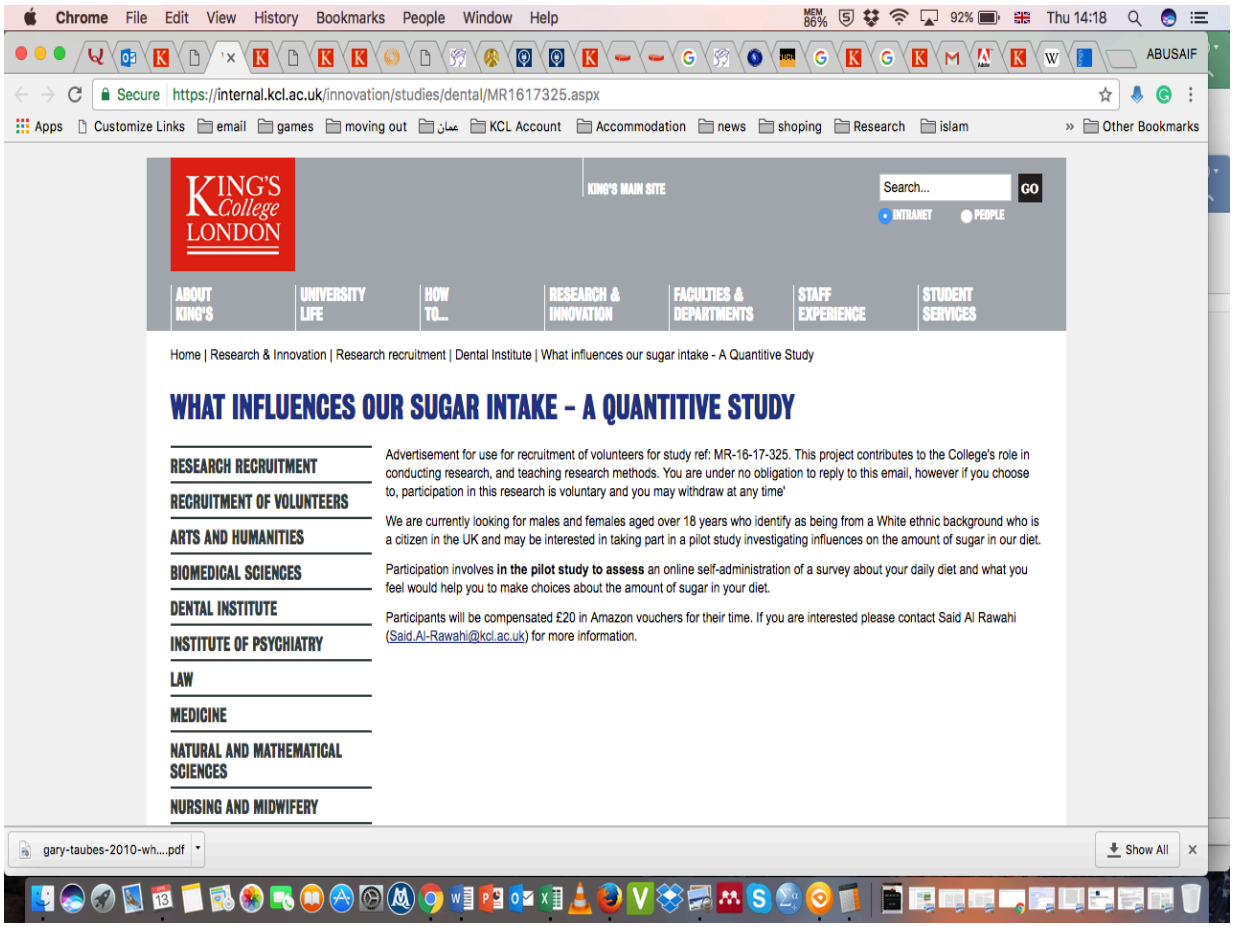
Q8 8

I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.

Q9 9

I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.

13.8.3. Advertisement at KCL



13.8.4. Information Sheet

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics Floor 18, Tower Wing

Guy's Hospital London Bridge SE1 9RW Tel 020784845145 Fax 02071887486

INFORMATION SHEET FOR PARTICIPANTS

King's College London - Research Ethics MR/16/17-325

Title of study: What influences our sugar intake? A Quantitative Study (As a Pilot)

We are pleased to invite you to take part in a research project. It is important for you to understand the reasons why we are undertaking for this research and what will be involved before you to decide to participate or not. Please take your time to read the following information carefully. Ask us if there is anything you need to have explained more clearly and we will be more than happy to assist you.

What is the purpose of the study?

The purpose of this study is to identify the potential facilitating factors and barriers which are associated with behavioural change in reducing the intake of free sugar to less than 5% of the total energy intake among **white ethnic adults and citizen in the UK.** In particular, we want to look at what influences the food you eat and what might influence people to reduce the amount of sugar in their diet.

Why have I been invited to take part?

We are asking White adults to take part. We are only asking White adults because previous research has shown that diet varies by ethnicity, and in the United Kingdom the White Ethnic group have the highest levels of sugar intake on average.

Do I have to take part?

It is up to you to decide whether to participate. If you do decide to participate, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason.

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics
Floor 18, Tower Wing

Guy's Hospital
London Bridge
SE1 9RW
Tel 020784845145
Fax 02071887486

What will happen to me if I take part?

If you agree to take part in our study please select I agree option below. Then, we will ask you to complete consent form and fill online self-administration of a survey about your daily diet related to sugar and what you feel would help you to make choices about the amount of sugar in your diet.

Are there any incentives?

As recognition of the time and effort involved in participation we will offer you a £10 Amazon voucher at the end of the interview as our way of saying " Thank you". The voucher will be sent you via email, so please make sure you type your email properly.

What are the possible risks of taking part?

We believe that there are no risks or disadvantages to taking part, the only inconvenience is the time taken to answer the questions.

Will my taking part be kept confidential?

Absolutely, all information which is collected about you during the course of the research will be kept strictly confidential. The data will be protected by our University procedures. The information you give us will be kept on a password protected computer and the data destroyed at the end of the study. Our procedures for handling, processing, storage, and destruction of your data are compliant with the Data Protection Act 1998.

How is the project being funded?

This project is part of Said Al Rawahi's PhD studies at King's College London.

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics
Floor 18, Tower Wing

Guy's Hospital
London Bridge
SE1 9RW
Tel 020784845145
Fax 02071887486

KING'S College LONDON

What will happen to the results of the study?

The results will be used part of an educational qualification for Said Al Rawahi as part of his PhD studies. We also hope to publish the research in academic journals. It will not be possible for any individual participant to be identified in any publication we produce. If you would like a summary of the findings of the study let us know and we will send you a summary at the end of our data analysis.

Who should I contact for further information?

If you have any questions or require further information about this study, please contact Said Al Rawahi using the following contact details:

Said.Al-Rawahi@kcl.ac.uk

Telephone: +44 (0) 20 3 299 3481

What if I have further questions, or if something goes wrong?

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact King's College London using the details below for further advice and information:

Tim. Newton PhD, CPsychol, AFBPS, FHEA
Professor of Psychology as applied to dentistry
Unit of Social and Behavioural Sciences
King's College London
Floor 18, Tower Wing

Koula Asimakopoulou, PhD, CPsychol, AFBPS, FHEA
Reader in Health Psychology
HCPC Registered Health Psychologist
Unit of Social and Behavioural Sciences
King's College London

Guy's, King's St Thomas' Dental Institute, Department of Orthodontics
Floor 18, Tower Wing

Guy's Hospital
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SE1 9RW
Tel 020784845145
Fax 02071887486

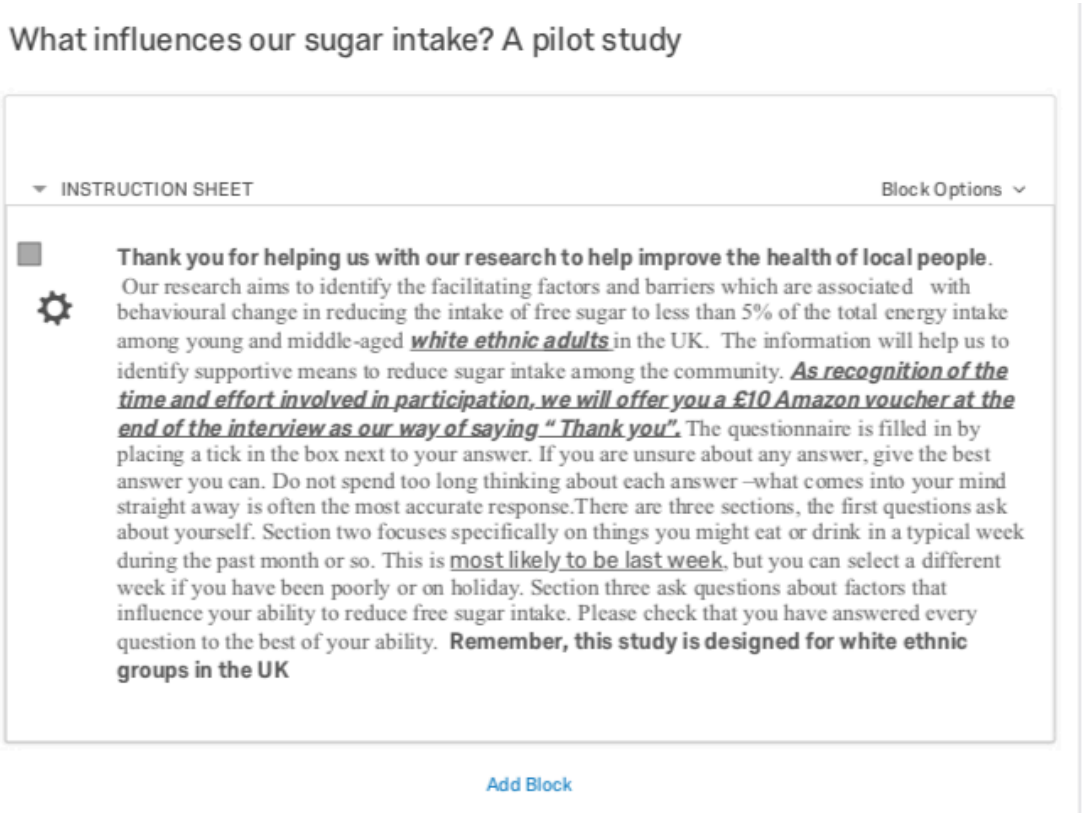
Guy's Hospital
London SE1 9RW
+44 (0) 20 7 848 5145
Tim.newton@kcl.ac.uk

Floor 18, Tower Wing
Guy's Hospital
London SE1 9RW
+44 (0) 207 848 5145
koula.asimakopoulou@kcl.ac.uk

The study ethical reference number is : MR/16/17-325 approved by [King's College London Research Ethics Minimal Risk Registration]. If you have any questions or complaints relating to the conduct of the research that have not been addressed satisfactorily by the research team please contact the BDM RESC (bdm@kcl.ac.uk)

Thank you for reading this information sheet and for considering taking part in this research

13.8.5. Instruction sheet



13.8.6. Pilot Online Survey

What influences our sugar intake? A pilot study

Start of Block: INSTRUCTION SHEET

Thank you for helping us with our research to help improve the health of local people. Our research aims to identify the facilitating factors and barriers which are associated with behavioural change in reducing the intake of free sugar to less than 5% of the total energy intake among young and middle-aged ***White ethnic adults*** in the UK. The information will help us to identify supportive means to reduce sugar intake among the community. ***As recognition of the time and effort involved in participation, we will offer you a £10 Amazon voucher at the end of the interview as our way of saying " Thank you".*** The questionnaire is filled in by placing a tick in the box next to your answer. If you are unsure about any answer, give the best answer you can. Do not spend too long thinking about each answer –what comes into your mind straight away is often the most accurate response.There are three sections, the first questions ask about yourself. Section two focuses specifically on things you might eat or drink in a typical week during the past month or so. This is most likely to be last week, but you can select a different week if you have been poorly or on holiday. Section three ask questions about factors that influence your ability to reduce free sugar intake. Please check that you have answered every question to the best of your ability. **Remember, this study is designed for White ethnic groups in the UK**

End of Block: INSTRUCTION SHEET

Start of Block: 1) CONSENT FORM

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research. ***King's College London Research Ethics Number is MR/16/17-325*** Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation is already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Q1 1

☐ I confirm that I understand that by ticking this box and each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study

Q2 2

☐ I confirm that I have read and understood the information sheet with Ethical Research number MR/16/17-325for the above study. I have had the opportunity to consider the information and asked questions which have been answered satisfactorily.

Q3 3

☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. Furthermore, I understand that I will be able to withdraw my data up to 31 May 2017.

Q4 4

☐ I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.

Q5 5

☐ I understand that my information may be subject to review by responsible individuals from the College for monitoring and audit purposes.

Q6 6

☐ I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications

Q7 7

☐ I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).

Q8 8

☐ I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.

Q9 9

☐ I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.

End of Block: 1) CONSENT FORM

Start of Block: 2) ABOUT YOU

Q6 Your Ethnicity:

- ○ White Scottish
- ○ White English
- ○ White Welsh
- ○ White Northern Irish
- ○ White British
- ○ White Irish
- ○ White Gypsy/traveller
- ○ Any other White Background, please describe:

_____

Q2 What is your age?

_____

Q3 Your Gender:

- ○ Male
- ○ Female
- ○ Not indicating

Q4 Highest Qualification:

- ○ Diploma
- ○ Bachelor/ BDS
- ○ Masters
- ○ Ph.D.
- ○ Others _____

Q5 Do you have any dental filling?

- ○ Yes
- ○ No
- ○ I don't Know

Q7 Your hight:

50 80 110 140 170 200 230 260 290 300

cm 

Q8 Your Weight:

30 50 70 90 110 130 150 170 190 200

Kilograms 

Q9 Over the last 12 months, would you say that on the whole, your health has been:

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

Q10 Does your household own or rent the accommodation in which you live?

- ○ Owns Outright
- ○ Owns with a mortgage or loan
- ○ Pays Part rent and part mortgage
- ○ Rents from council
- ○ Rents from a housing association
- ○ Rents from a private landload
- ○ Accommodation is a residential home or student halls
- ○ Others _____

Q11 Where do you live?

▼ North East England ... Northern Ireland

End of Block: 2) ABOUT YOU

Start of Block: 3) FOOD AND DRINKS INTAKE:

The following questions ask about some foods & drinks you might have during a 'typical' week, over the past month or so. Do not be concerned if some things you eat or drink are not mentioned. The following questions ask about some foods & drinks you might have during a 'typical' week, over the past month or so. Do not be

concerned if some things you eat or drink are not mentioned. *(Please only put one tick, but answer **EVERY** line)*

Q1 **Please tick how often you eat at least ONE portion of the following foods & drinks**: (a portion includes: a handful of grapes, an orange, a serving of carrots, a side salad, a slice of bread, a glass of pop).

	Never or less than once/ month	1-3 per month	once a week	2-4 times per week	5-6 times per week	Once a day	2-3 times per day	4-5 times per day	6+ per day
Dairy desserts (125g carton)	○	○	○	○	○	○	○	○	○
Salad cream mayonnaise (Tablespoon)	○	○	○	○	○	○	○	○	○
French dressing (Tablespoon)	○	○	○	○	○	○	○	○	○
Other salad dressing (Tablespoon)	○	○	○	○	○	○	○	○	○
Sweet biscuits, chocolate, e.g. digestive (one)	○	○	○	○	○	○	○	○	○
Sweet biscuits, plain, e.g. Nice, Ginger (one)	○	○	○	○	○	○	○	○	○
Cakes eg. Fruit, sponge, home baked	○	○	○	○	○	○	○	○	○
Cakes eg. Fruit, sponge, ready made	○	○	○	○	○	○	○	○	○
Burns, pastries eg. Scones, flapjacks, home baked	○	○	○	○	○	○	○	○	○
Burns, pastries eg. pastries eg. Croissants, doughnuts, ready made	○	○	○	○	○	○	○	○	○

Fruit pies, tats, crumbles, home baked	○	○	○	○	○	○	○	○	○
Fruit pies, tats, crumbles, ready made	○	○	○	○	○	○	○	○	○
Sponge puddings, home baked	○	○	○	○	○	○	○	○	○
Sponge puddings, ready made	○	○	○	○	○	○	○	○	○
Milk puddings, eg. Rice , custard, trifle	○	○	○	○	○	○	○	○	○
Ice cream, choc ices	○	○	○	○	○	○	○	○	○
Chocolates, single or squares	○	○	○	○	○	○	○	○	○
Chocolate snack bars eg. Mars, Crunchie	○	○	○	○	○	○	○	○	○
Sweets, Toffees, mints	○	○	○	○	○	○	○	○	○
Sugar added to tea, coffee, cereals (teaspoon)	○	○	○	○	○	○	○	○	○
Crisps or toher packet snacks, e.g. Wotsits	○	○	○	○	○	○	○	○	○
Peanuts or other nuts	○	○	○	○	○	○	○	○	○
Vegetable Soups (Bowl)	○	○	○	○	○	○	○	○	○

Meat soup (Bowl)	○	○	○	○	○	○	○	○	○
Sauces, eg. White sauce, cheese sauce, gravy (tablespoon)	○	○	○	○	○	○	○	○	○
Tomato ketchup (tablespoon)	○	○	○	○	○	○	○	○	○
Pickles, chutney (tablespoon)	○	○	○	○	○	○	○	○	○
Marmite, Bovril (teaspoon)	○	○	○	○	○	○	○	○	○
Jam, Marmalade, honey (teaspoon)	○	○	○	○	○	○	○	○	○
Peanut butter (teaspoon)	○	○	○	○	○	○	○	○	○
Tea (cup)	○	○	○	○	○	○	○	○	○
Coffee, instant or Ground (cup)	○	○	○	○	○	○	○	○	○
Coffee, decaffeinated eg. Coffee-mate (teaspoon)	○	○	○	○	○	○	○	○	○
Cocoa, hot Chocolate (cup)	○	○	○	○	○	○	○	○	○
Horlicks, Ovaltine (Cup)	○	○	○	○	○	○	○	○	○
Wine (Glass)	○	○	○	○	○	○	○	○	○
Beer, lager or cider (half pint)	○	○	○	○	○	○	○	○	○

Port, Sherry, Vermouth, Liqueurs (glass)	○	○	○	○	○	○	○	○	○
Spirits, eg gin, brandy, whisky, vodka (single)	○	○	○	○	○	○	○	○	○
Low calorie or diet fizzy soft drinks (glass)	○	○	○	○	○	○	○	○	○
Fizzy soft drinks eg. Coca Cola, lemonade (glass)	○	○	○	○	○	○	○	○	○
Pure fruit juice (100%) eg. Orange apple juice. (glass)	○	○	○	○	○	○	○	○	○
Fruit squash or cordial (glass)	○	○	○	○	○	○	○	○	○
Tinned fruits (medium serving)	○	○	○	○	○	○	○	○	○

Q2 **Are there any OTHER sugary foods or meal which you ate more than once a week?**

○ Yes

○ No

Skip To: Q4 If Are there any OTHER sugary foods or meal which you ate more than once a week? = No

Q3 If Yes, please list below:

	Food/ Meal	Usual serving Size	Number of time eaten each week
1			
2			
3			
4			
5			
6			
7			
8			
9			

Q4 **What milk do you <u>usually</u> use or drink, such as in hot & cold drinks or on cereal?** (including tea, coffee, hot milk, milk shakes, or on cereal)

- ☐ Whole / full-fat milk, silver
- ☐ Semi-skimmed milk red/ White
- ☐ Skimmed milk/ blue
- ☐ Channel Islands, gold
- ☐ Dried milk
- ☐ Soya
- ☐ Rarely/never use milk
- ☐ Other (please write its name):

_____

Q5 **How much milk did you drink each day, including milk with tea, coffee, cereals etc ?**

- ○ None
- ○ Quarter of pint
- ○ Half a pint
- ○ Three quarters of a pint
- ○ one pint
- ○ More than one pint

Q38 **Did you usually eat breakfast cereal (excluding porridge and ready Brek mentioned earlier** ?

- ○ Yes
- ○ No

Skip To: End of Block If Did you usually eat breakfast cereal (excluding porridge and ready Brek mentioned earlier ? ... = No

Q39 **if Yes, please list below:**

	Brand e.g. Kellogg's	Types e.g. Cornflakes
1		
2		
3		
4		
5		

End of Block: 3) FOOD AND DRINKS INTAKE:

Start of Block: 4) FREE SUGAR INTAKE:

Q48 The following questions ask about your opinion and experience related to free sugar intake. Do not be concerned if some things you eat or drink are not mentioned. (Please only put one tick, but answer EVERY line)
KQ1 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I feel I have good knowledge of which food and drinks can cause tooth decay.	○	○	○	○	○
I feel I have good knowledge of which foods are healthy for teeth.	○	○	○	○	○
I feel I have good knowledge of which foods are acidic.	○	○	○	○	○
I feel I have good knowledge of the amount of sugar in the food I eat.	○	○	○	○	○
I feel I have good knowledge of when to eat sugary food in order to minimise the damage to my teeth.	○	○	○	○	○
I feel I understand the term "free sugar".	○	○	○	○	○
I feel I understand the term "added sugar".	○	○	○	○	○
I feel I have good knowledge of the daily recommended sugar intake.	○	○	○	○	○

I feel I understand the colour coding system in food packaging.	○	○	○	○	○
I have the knowledge I need to choose food with low calories	○	○	○	○	○
I feel I understand the food labelling system.	○	○	○	○	○
I feel I need more information about the effects of sugar on my body.	○	○	○	○	○
I feel I need more information about the effects of sugar on my teeth.	○	○	○	○	○
I feel I need more information on the recommended daily sugar intake.	○	○	○	○	○
I feel I need more information about the colour coding system for food packaging	○	○	○	○	○
I feel I need more information about hidden sugars in food	○	○	○	○	○

I feel I need more information about the foods that I eat	○	○	○	○	○
I feel I need more information about health eating	○	○	○	○	○
I feel I need more information about the different types of sugar.	○	○	○	○	○
I feel I need more information about the sugar content of processed foods and ready meals.	○	○	○	○	○
I feel I need more information about how exercise affects my sugar intake.	○	○	○	○	○

Page Break

PsSQ2 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	not sure	Disagree	Strongly disagree
I find it easy to calculate my daily sugar intake	○	○	○	○	○
I find it easy to assess the sugar content of foods or meals	○	○	○	○	○
I find it easy to interpret the labelling on food products	○	○	○	○	○

Page Break

MADPQ3 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I choose food with lower sugar on a daily basis.	○	○	○	○	○
I occasionally choose food with a high sugar content	○	○	○	○	○
I trust the food labelling system	○	○	○	○	○
I have a good recall of the sugar intake advice.	○	○	○	○	○
I have a good idea of the amount of sugar in foods	○	○	○	○	○
I choose food with low calories	○	○	○	○	○
The colour coding system on food packaging helps me to compare and select between two products quickly.	○	○	○	○	○
Colour coding attracts my attention when selecting foods	○	○	○	○	○
Colour coding helps me distinguish between healthy and unhealthy food	○	○	○	○	○

I often choose foods or meals that have been reduced in price	○	○	○	○	○
I think carefully about my sugar intake.	○	○	○	○	○
The effect of sugar on body weight is more important to me than its effect on teeth .	○	○	○	○	○
I prioritise the taste of food over health concerns.	○	○	○	○	○
I pay attention to sugar intake when buying food than buying ready meals .	○	○	○	○	○
I pay attention to the sugar content of foods.	○	○	○	○	○
I always look at the nutritional value of foods I buy.	○	○	○	○	○
I think that having a picture of tooth decay on food packaging would attract my attention.	○	○	○	○	○

I focus on the colour coding on the product label when purchasing it.	○	○	○	○	○

BRQ4 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I plan a daily sugar intake.	○	○	○	○	○
I always select a small portion of sugary food	○	○	○	○	○
I prioritise fresh food.	○	○	○	○	○
I prioritise body weight and fitness rather than oral health when I am eating	○	○	○	○	○
I feel I need a system to monitor my food intake	○	○	○	○	○

Page Break

PhSQ5 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I select healthy food	○	○	○	○	○
I select cheap food	○	○	○	○	○
I prepare healthy food	○	○	○	○	○
I find it easy to identify the sugar content on food packaging	○	○	○	○	○
I feel I need more cooking skills.	○	○	○	○	○

Page Break

SIQ6 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
My parents had a strong influence on what I eat.	○	○	○	○	○
My parent's beliefs are a strong influence on my beliefs about sugar intake.	○	○	○	○	○
My parents would not like a picture of tooth decay on food packaging	○	○	○	○	○
My partner has a strong influence on what I eat.	○	○	○	○	○
My friends are strong influences on what I eat.	○	○	○	○	○
I am influenced in my choice of food by other cultures.	○	○	○	○	○
Health professionals are strong influences on what I eat.	○	○	○	○	○
My friends' experience of ill health is a strong influence on what I eat.	○	○	○	○	○

ECRQ7 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I think restaurants foods are expensive.	○	○	○	○	○
I think vegetables are cheap food.	○	○	○	○	○
I think healthy food are cheap.	○	○	○	○	○
Fruit is free in my place of work.	○	○	○	○	○
I think social media is a good source of information for foods.	○	○	○	○	○
I think when I am ill I drink more sweet drinks.	○	○	○	○	○
I think when I am ill I drink more fruit juice.	○	○	○	○	○
I think when I am ill I eat more sweet foods.	○	○	○	○	○
I have limited access to healthy food.	○	○	○	○	○
I am influenced by store promotions when buying food.	○	○	○	○	○
I am influenced by advertisements for food.	○	○	○	○	○
I can easily get sweet foods wherever I am.	○	○	○	○	○

I am concerned about cost when I buy foods.	○	○	○	○	○
I think it is difficult to know how much sugar is in restaurant meals.	○	○	○	○	○
I am influenced by TV programmes or advertisements in choosing what to eat.	○	○	○	○	○
I think many foods and drinks have too much of sugar.	○	○	○	○	○
I think the sugar contents are given on the packaging of foods.	○	○	○	○	○
I think food labelling is difficult to understand.	○	○	○	○	○
I think the size of a serving on food labelling is difficult to understand.	○	○	○	○	○
I think food products have a colour coding system.	○	○	○	○	○
I think food labels are often in a small font which make it difficult to read.	○	○	○	○	○
I think there is education about sugar in food through TV shows.	○	○	○	○	○

I am aware there are media campaigns about reducing sugar consumption.	○	○	○	○	○
I think Fitness pal or apps are not helpful in reducing my sugar intake.	○	○	○	○	○
I think there are no apps that can count sugar content.	○	○	○	○	○
I think the text of labelling of sugar in foods should be wide or big warning number of sugar content.	○	○	○	○	○
I think the food label should clearly state the amount of sugar in the food.	○	○	○	○	○
I think food labels should include daily recommendations of sugar intake for men and women.	○	○	○	○	○
I think labelling of sugar in foods should be in percentage form.	○	○	○	○	○
I think labelling of sugar in foods should be in gram form.	○	○	○	○	○
I think labelling of sugar in foods should be in both grams and percentage forms.	○	○	○	○	○

I think labelling of sugar in foods should state the recommended individual's daily intake against percentage of sugar content of a food.	○	○	○	○	○
I think labelling of sugar in foods should include the total amount of sugar intake of a product.	○	○	○	○	○
I think labelling of sugar in foods should be a simple colour scheme.	○	○	○	○	○
I think labelling of sugar in foods should be clearly visible on the front of the product.	○	○	○	○	○
I think the colour coding system needs to be publicised and advertised e.g. TV.	○	○	○	○	○
I think the colour coding system needs to be clearer.	○	○	○	○	○
I think that a picture of tooth decay should be put on the packaging of sugary and fizzy drinks.	○	○	○	○	○
I think education about sugar in food should be advertised on the internet on buses etc.	○	○	○	○	○

I think there should be more campaigns about sugar consumption including sugar in food.	○	○	○	○	○
I think GP's should provide information about sugar.	○	○	○	○	○
I would like nutritional classes in my workplace.	○	○	○	○	○
I think the price of vegetables and fruits should be reduced.	○	○	○	○	○
I think there should be posters about sugar reduction in foods in supermarkets and shops.	○	○	○	○	○
I think the recommended intake of sugar should be increased to 30%.	○	○	○	○	○

Page Break

SPRI (R)Q8 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
My past social experience influences my sugar intake.	○	○	○	○	○
My past experience with my parent influences sugar intake.	○	○	○	○	○
My professional identity influences my sugar intake.	○	○	○	○	○
My social identity influences my sugar intake.	○	○	○	○	○
My personality influences my sugar intake.	○	○	○	○	○
It is human nature to eat a lot of sugar.	○	○	○	○	○
My family background influences my sugar intake.	○	○	○	○	○
I like to be in control of my life, including my sugar intake.	○	○	○	○	○

BACaQ9 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I believe it is easy to identify the amount of sugar in food when you cook it.	○	○	○	○	○
I believe I can quantify my sugar intake.	○	○	○	○	○
I believe that I can find out the sugar content in food from the label.	○	○	○	○	○
I believe I can understand food labelling in percentage only.	○	○	○	○	○
I believe I can understand food labelling in grams only.	○	○	○	○	○
I believe I can understand food labelling in grams and percentage.	○	○	○	○	○
I believe I can find the sugar content in food from the packaging.	○	○	○	○	○
I believe I can easily calculate my amount of sugar intake per day.	○	○	○	○	○
I believe it’s difficult to control my sugar intake.	○	○	○	○	○
I believe I can't reduce my intake of sweet snacks.	○	○	○	○	○

I believe it is easy to get sweets.	○	○	○	○	○
I believe I am lazy in my food choices.	○	○	○	○	○
I believe it is hard to know the sugar content of meals.	○	○	○	○	○
I believe it's difficult to control the influence of advertisements.	○	○	○	○	○
I believe it is difficult to read food labels.	○	○	○	○	○
I believe I can't understand food labels.	○	○	○	○	○

Page Break

OQ10 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I am sure that food labelling is key when buying food for the first time to reduce sugar intake.	○	○	○	○	○
I am sure that colour coding will help in selecting low sugar food.	○	○	○	○	○
I am sure that colour coding attracts my attention.	○	○	○	○	○
I am sure that colour coding facilitates comparing foods in order to select the one with lower sugar.	○	○	○	○	○
I am sure that the most effective way to reduce sugar intake is by placing a tooth decay image on a food product.	○	○	○	○	○
I am confident that education about sugar in food will reduce the sugar intake in children.	○	○	○	○	○
I am sure that education on sugar in food will work for me.	○	○	○	○	○

I am confident that a sugar tax will help to reduce the sugar intake of the nation.	○	○	○	○	○

Page Break

IQ11 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I intend not to buy sugary foods.	○	○	○	○	○
I intend to reduce my sugar intake.	○	○	○	○	○
I intend to eat healthy food.	○	○	○	○	○
I intend to do exercise.	○	○	○	○	○
I intend to buy unhealthy food.	○	○	○	○	○

Page Break

GQ12 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not Sure	Disagree	Strongly disagree
I aim to reduce my weight.	○	○	○	○	○
I aim to get in good physical shape.	○	○	○	○	○
I aim to gain weight.	○	○	○	○	○
I aim to keep my teeth healthy.	○	○	○	○	○

RQ13 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I think sweets are good rewards.	○	○	○	○	○
Colour coding reinforces selection of healthy food.	○	○	○	○	○
A label telling me how much exercise I need to do to burn off the food rewards my behaviour.	○	○	○	○	○
Education about sugar reinforces my decisions about reducing sugar intake.	○	○	○	○	○

Page Break

SPRI (A)Q14 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I think my sugar intake is the result of habit.	○	○	○	○	○
My social class and political identity influence my sugar intake.	○	○	○	○	○
I cook food every day.	○	○	○	○	○
I was brought up by my parent to eat meals with less sugar.	○	○	○	○	○
My craving for sugar is a habit.	○	○	○	○	○
I buy sweets every day.	○	○	○	○	○
My sugar intake changes when I am on holiday.	○	○	○	○	○
I have a habit of sharing with others including foods.	○	○	○	○	○
I think education about sugar in food during childhood will develop a good habit for reduced sugar intake.	○	○	○	○	○

Page Break

EQ15 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I feel guilty after eating sweets.	○	○	○	○	○
I dislike sugary foods.	○	○	○	○	○
I like the taste of hot drinks (e.g. Coffee and Tea) without sugar.	○	○	○	○	○
I like the taste of cold drinks without sugar .	○	○	○	○	○
I like the taste of fruits.	○	○	○	○	○
I love fruit with a main meal.	○	○	○	○	○
I love fruit as snack	○	○	○	○	○
I crave fizzy drinks.	○	○	○	○	○
My body craves sweets	○	○	○	○	○
I love drinking Coca Cola .	○	○	○	○	○
I want tasty foods	○	○	○	○	○
My treats are sweets.	○	○	○	○	○
I love bargain foods	○	○	○	○	○

I have no interest in counting sugar content of foods.	○	○	○	○	○
A tooth decay image on packaging will make me afraid of getting picture of tooth decay.	○	○	○	○	○
A tooth decay image on packaging will be annoying.	○	○	○	○	○
A tooth decay image on packaging will make me feel guilty.	○	○	○	○	○
A tooth decay image on packaging will make me feel that I have no autonomy in my decision.	○	○	○	○	○
A tooth decay image on packaging is horrible.	○	○	○	○	○
I have negative experience with fitness apps like Fitness Pal.	○	○	○	○	○

Page Break

BACoQ16 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I believe that sweets are not very healthy.	○	○	○	○	○
I believe that natural occurring sugar in fruits and vegetables is healthy.	○	○	○	○	○
I believe that cooking food has healthy consequences.	○	○	○	○	○
I believe that exercise helps to consume less sweet food.	○	○	○	○	○
I believe that performing exercise without reducing sugar intake is healthy.	○	○	○	○	○
My parent's beliefs are a strong influence on my beliefs about sugar intake.	○	○	○	○	○
I believe that consuming sugar is fine as long as I do exercise.	○	○	○	○	○
I believe that drinking a lot of fruit juice reduces illness.	○	○	○	○	○

I believe that drinking fizzy drink has positive consequences e.g. boost energy.	○	○	○	○	○
I believe having high sugar intake (many sugary drinks and food) is okay	○	○	○	○	○
I believe having normal sugar intake is okay.	○	○	○	○	○
I believe exercise increases snacking.	○	○	○	○	○
I believe low sugar foods taste bad.	○	○	○	○	○
I believe only high fat and high calorie foods are bad for me.	○	○	○	○	○
I believe that food labels giving the percentage of sugar is helpful in reducing sugar intake.	○	○	○	○	○
I believe that food labels giving the grams of sugar is helpful in reducing sugar intake	○	○	○	○	○

I believe that food labels giving the grams and percentage of sugar is helpful in reducing sugar intake.	○	○	○	○	○
I believe that food labelling giving the grams and percentage helpful with ready meals.	○	○	○	○	○
I believe that food labelling giving the grams and percentage helpful with sugary foods e.g. sweets.	○	○	○	○	○
I believe that presenting food content in percentage or grams alone is useless.	○	○	○	○	○
I believe that food labelling in grams and percentages is not helpful after the food is prepared into a meal.	○	○	○	○	○
I believe that colour coding system leads to selection of low sugar food by attracting your attention.	○	○	○	○	○

I believe that colour coding system leads to selection of low sugar food by allowing comparison between food products.	○	○	○	○	○
I believe that colour coding helps to focus me to think about the content of the products.	○	○	○	○	○
I believe that colour coding leads to more awareness of food choice.	○	○	○	○	○
I believe that colour coding won't reduce sugar intake for a normal person.	○	○	○	○	○
I believe that colour coding is a very poor way of presenting information.	○	○	○	○	○
I believe that an amount of exercise to burn off energy label leads to thinking about food consumption before eating.	○	○	○	○	○

I believe that an amount of exercise to burn off energy label increases awareness of how much exercise you need to do to burn off energy.	○	○	○	○	○
I believe that an amount of exercise to burn off energy label helps to control sweet snacks.	○	○	○	○	○
I believe that an amount of exercise to burn off energy label encourages healthy meals.	○	○	○	○	○
I believe that an amount of exercise to burn off energy label will not influence the choices of a healthy person.	○	○	○	○	○
I believe that an amount of exercise to burn off energy label encourages consumption of sugary food.	○	○	○	○	○

I believe that amount of exercise to burn off energy label is not useful for people who are not performing exercise.	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging is acceptable on a sugary drink.	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging will help to reduce the need for dental treatment.	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging will reduce sugar intake.	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging is acceptable in sugary food.	○	○	○	○	○

I believe that placing a picture of tooth decay on food packaging has no influence on an individual with no dental decay.	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging will be rejected by the public	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging will have effect on reducing sugar intake.	○	○	○	○	○
I believe that placing a picture of tooth decay on food packaging will lead to feeling guilty.	○	○	○	○	○
I believe that education about sugar in food will lead to good results for my body and health.	○	○	○	○	○
I believe that education about sugar in food enables me to make judgement on sugar intake.	○	○	○	○	○

I believe that education about sugar in food helps me to decide on healthy food.	○	○	○	○	○
I believe that education about sugar in food has no effect on me.	○	○	○	○	○
I believe that a sugar or food tax helps the nation to reduce sugar intake.	○	○	○	○	○
I believe that sugar or food tax reduces the frequency of sugar intake.	○	○	○	○	○
I believe that high sugar tax reduces sugar intake only.	○	○	○	○	○
I believe that high sugar tax has no effect for people with low sugar consumption.	○	○	○	○	○
I believe that high sugar tax has no effect on reducing sugar intake.	○	○	○	○	○
I believe that high sugar tax leads to selecting the cheapest sugary food.	○	○	○	○	○

I believe that labelling packaging with sugar amounts against the recommended level of intake will result in selecting food with low sugar.	○	○	○	○	○
I believe that the percentage of individual 's daily intake will be useful in helping people to think about the food before buying it.	○	○	○	○	○
I believe that clear and obvious labelling will make individuals think carefully about food with high sugar	○	○	○	○	○
I believe that clear and obvious labelling will encourage individuals to set a plan for daily sugar intake.	○	○	○	○	○

Page Break

BQ17 Please read the statements related to sugar consumption and tick the best possible options that match with your opinion and experience:

	Always	Usually	About half the time	Seldom	Never
I add sugar in hot drinks (e.g. tea or coffee).	○	○	○	○	○
I select sweet food.	○	○	○	○	○
I select foods with high sugar.	○	○	○	○	○
I add sugar in foods when I am eating (e.g. cereal).	○	○	○	○	○
I add sugars when I am cooking food.	○	○	○	○	○

End of Block: 4) FREE SUGAR INTAKE:

Start of Block: Block 5

Q49 Please type your email address below (to receive the incentive):

_____

Thank so much for taking part in this survey

End of Block: Block 5

13.9. Supplment of the Quanititive Study

13.9.1. Ethical approval

Research Ethics Office
King's College London
Rm 5.11 FWB (Waterloo Bridge Wing)
London
SE1 9NH

14 March 2017
TO: Said Al-Rawahi
SUBJECT: Confirmation of Registration for "What influences our sugar intake? A Quantitive Study"

Dear Said

Thank you for submitting your Research Ethics Minimal Risk Registration Form. This letter acknowledges the receipt of your registration; your Research Ethics Number is **MR/16/17-325**. You may begin collecting data immediately.

Be sure to keep a record your registration number and include it in any materials associated with this research. Registration is valid for **one year** from today's date. Please note it is the responsibility of the researcher to ensure that any other permissions or approvals (i.e. R&D, gatekeepers, etc.) relevant to their research are in place, prior to conducting the research.

Record Keeping:
In addition, you are expected to keep records of your process of informed consent and the dates and relevant details of research covered by this application. For example, depending on the type of research that you are doing, you might keep:

- A record of the relevant details for public talks that you attend, the websites that visit, the interviews that you conduct
- The 'script' that you use to inform possible participants about what your research involves. This may include written information sheets, or the generic information you include in the emails you write to possible participants, or what you say to people when you approach them on the street for a survey, or the introductory material stated at the top of your on-line survey.
- Where appropriate, records of consent, e.g. copies of signed consent forms or emails where participants agree to be interviewed.

Audit:
You may be selected for an audit, to see how researchers are implementing this process. If audited, you will be expected to explain how your research abides by the general principles of ethical research. In particular, you will be expected to provide a general summary of your review of the possible risks involved in your research, as well as to provide basic research records (as above in Record Keeping) and to describe the process by which participants agreed to participate in your research.

Remember that if you have any questions about the ethical conduct of your research at any point, you should contact your supervisor, the Research Ethics office, or a member of your Department's Research Ethics Panel for advice.

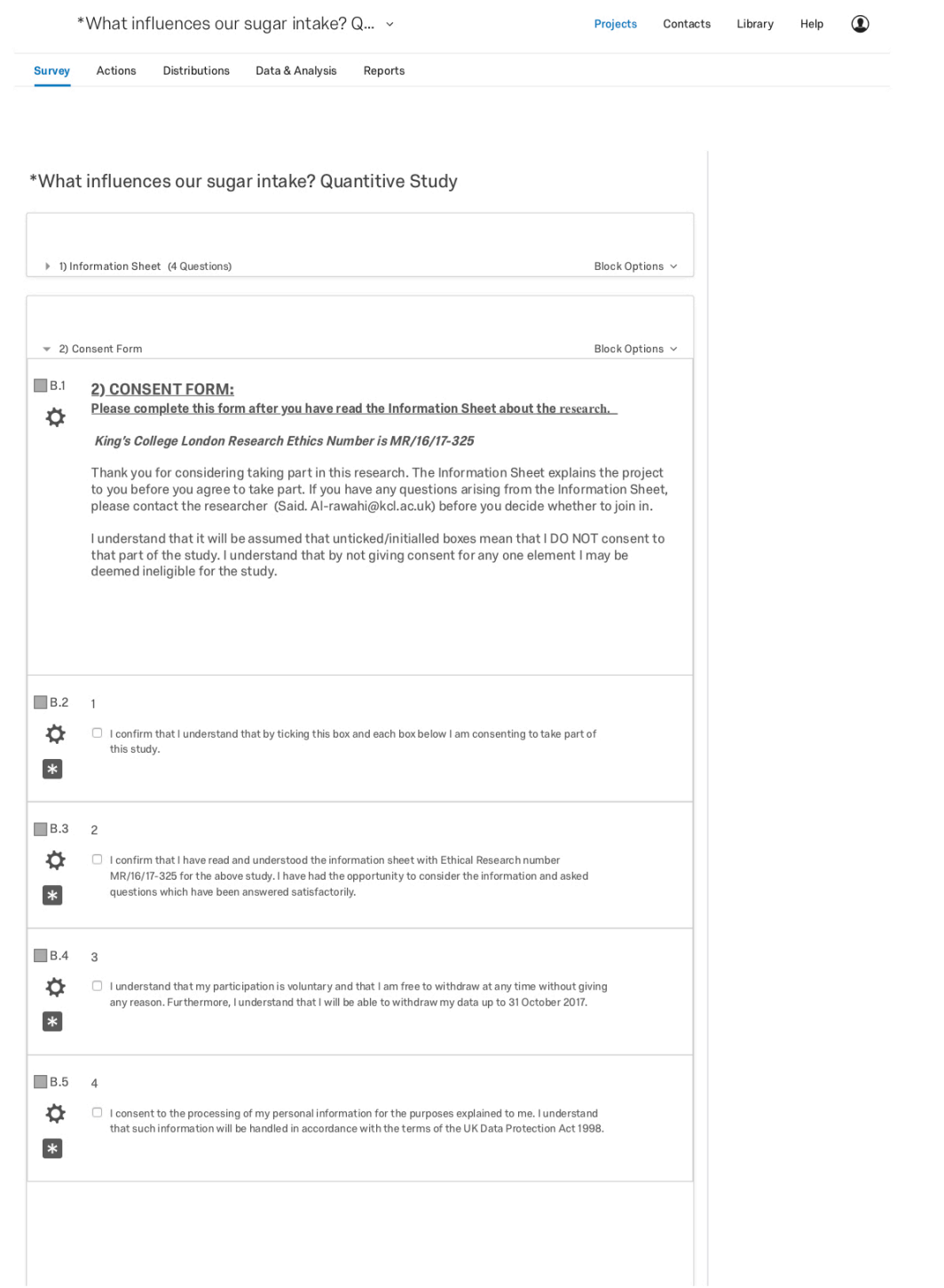
Feedback:
If you wish to provide any feedback on the process you may do so by emailing crec-minrisk@kcl.ac.uk .

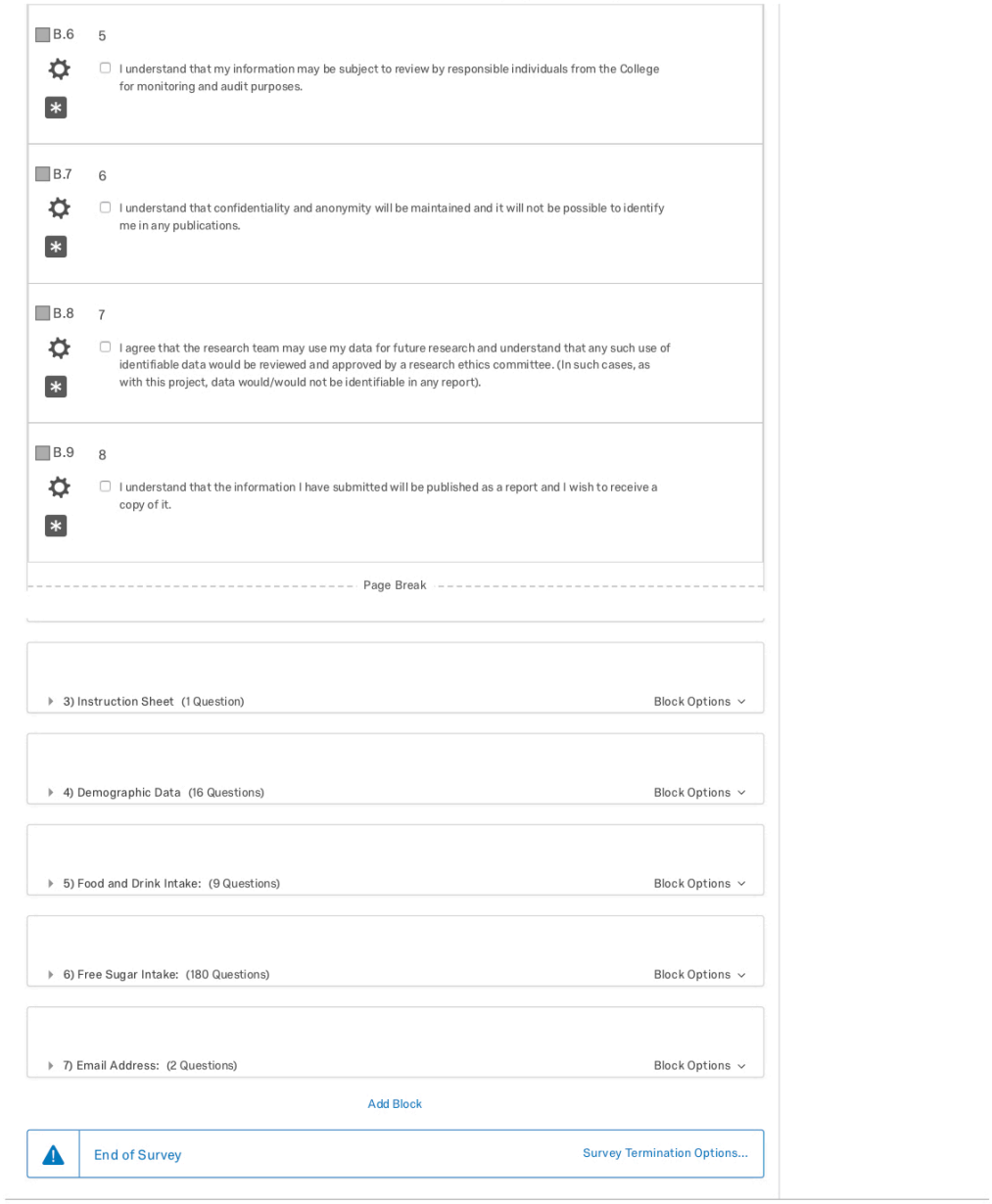
We wish you every success with this work.

With best wishes

Research Ethics Office

13.9.2. Consent form




B.6
5
I understand that my information may be subject to review by responsible individuals from the College for monitoring and audit purposes.
B.7
6
I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications.
B.8
7
I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).
B.9
8
I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.
Page Break
3) Instruction Sheet (1 Question) Block Options
4) Demographic Data (16 Questions) Block Options
5) Food and Drink Intake: (9 Questions) Block Options
6) Free Sugar Intake: (180 Questions) Block Options
7) Email Address: (2 Questions) Block Options
Add Block
End of Survey
Survey Termination Options...
Qualtrics.com
Contact Information
Legal

13.9.3. Advertisement:

13.9.3.1. KCL

WHAT INFLUENCES OUR SUGAR INTAKE? A QUANTITATIVE STUDY

Advertisement for use for recruitment of volunteers for study ref: MR/16/17-325 approved by King's College London Research Ethics Minimal Risk Registration. This project contributes to the College's role in conducting research, and teaching research methods. You are under no obligation to reply to this email, however if you choose to, participation in this research is voluntary and you may withdraw at any time.

We are currently looking for males and females aged over 18 years who may be interested in taking part in a study investigating influences on the amount of sugar in our diet. Participation involves an online self-administration of a survey about your daily diet and what you feel would help you to make choices about the amount of sugar in your diet.

Participants will be compensated £20 in Amazon vouchers for their time after fully completing the survey.

If you are interested please contact Said Al Rawahi (Said.Al-Rawahi@kcl.ac.uk) for more information.

13.9.3.2. Call for participant

Jisc R&D

CALL FOR PARTICIPANTS | TAKE PART IN RESEARCH | HELP | MY ACCOUNT

HOME > FIND RESEARCH > STUDY OVERVIEW EDIT STUDY

What influences our sugar intake? A Quantitative Study.

23 August 2017

The purpose of this study is to identify the potential facilitating factors and barriers which are associated with the behavioural change in reducing the intake of free sugar to less than 5% of the total energy intake among particular ethnic adults. In particular, we want to look at what influences the food you eat and what might influence people to reduce the amount of sugar in their diet.

Requirements

- Adult aged 18 years and over

☐ YES, I MEET THESE REQUIREMENTS

TAKE PART IN THIS STUDY

Keywords

King's College London | Behaviour Change | Sugar Intake | Adults | Influential Factors | Tooth Decay

Ethical approval

This Study has been approved by King's College London Research Ethics Office. The Research Ethics Number is MR/16/17-325.

ACADEMIC STUDY

STUDY ESSENTIALS

- King's College London, GB
- 110 min(s) to complete
- £ 20 Amazon Voucher
- Online Questionnaire

ONLINE

Online research

SHARE THIS STUDY

- Facebook
- Twitter
- Google
- LinkedIn
- Reddit
- Pinterest
- Email this study
- Print a poster version (PDF)

About the researcher

My name is Said Al Rawahi, a PhD student at King's College London, conducting a research related to sugar intake and tooth decay among adults.

Contact researcher

DISCOVER MORE

HOME
ABOUT US
HELP
CREATE YOUR OWN STUDY PAGE
RESEARCHER SUPPORT
PRIVACY POLICY
TERMS & CONDITIONS
CONTACT
BLOG

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King's College London
University College London
University of Leeds University of Bath
Sincere Gratitude Brunel University

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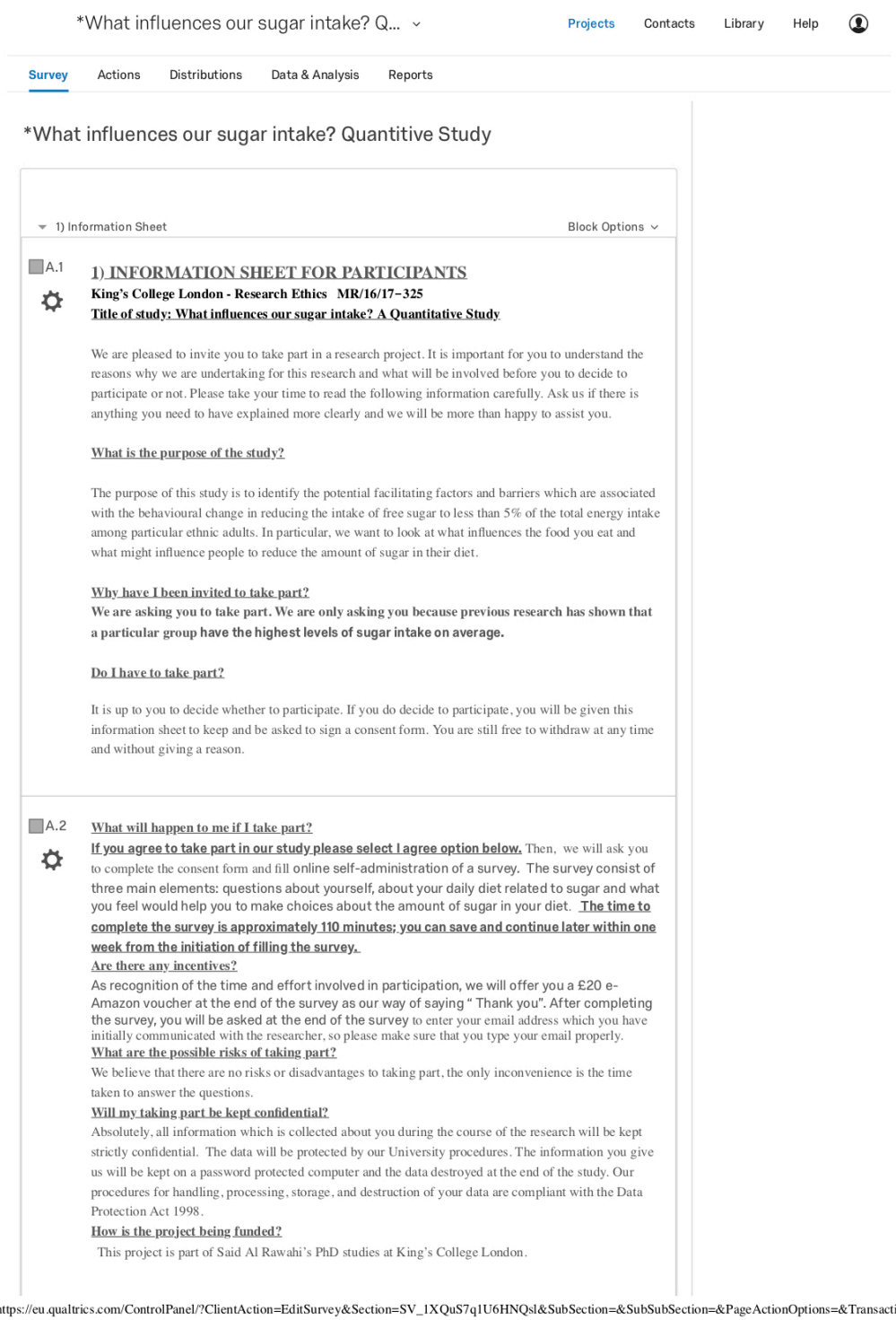
CallForParticipants
@CFP_uk

Some problems are very easy to solve while others are not, but why? Help @QMUniversity scientists figure out cfp.cc/VDD4FT #CfP

Thinking Divergently abo...

FOLLOW US

13.9.4. Information Sheet



A.3 **What will happen to the results of the study?**

The results will be used part of an educational qualification for Said Al Rawahi as part of his PhD studies. We also hope to publish the research in academic journals. It will not be possible for any individual participant to be identified in any publication we produce. If you would like a summary of the findings of the study let us know and we will send you a summary at the end of our data analysis.

Who should I contact for further information?

If you have any questions or require further information about this study, please contact Said Al Rawahi using the following contact details:
Said.Al-Rawahi@kcl.ac.uk
Telephone: +44 (0) 20 3 299 3481

What if I have further questions, or if something goes wrong?

Please contact Said Al Rawahi using the following contact details:
Said.Al-Rawahi@kcl.ac.uk

	The study ethical reference number is: MR/16/17-325 approved by [King's College London Research Ethics Minimal Risk Registration]. If you have any questions or complaints relating to the conduct of the research that have not been addressed satisfactorily by the research team please contact the BDM RESC (bdm@kcl.ac.uk)

Thank you for reading this information sheet and for considering taking part in this research

A.4 Please select one of the folloiwng:

- ○ I AGREE to participate in the study
- ○ I DISAGREE to participate in the study

Condition: I DISAGREE to participate i... Is Selected. Skip To: End of Survey.

▸ 2) Consent Form (9 Questions) Block Options

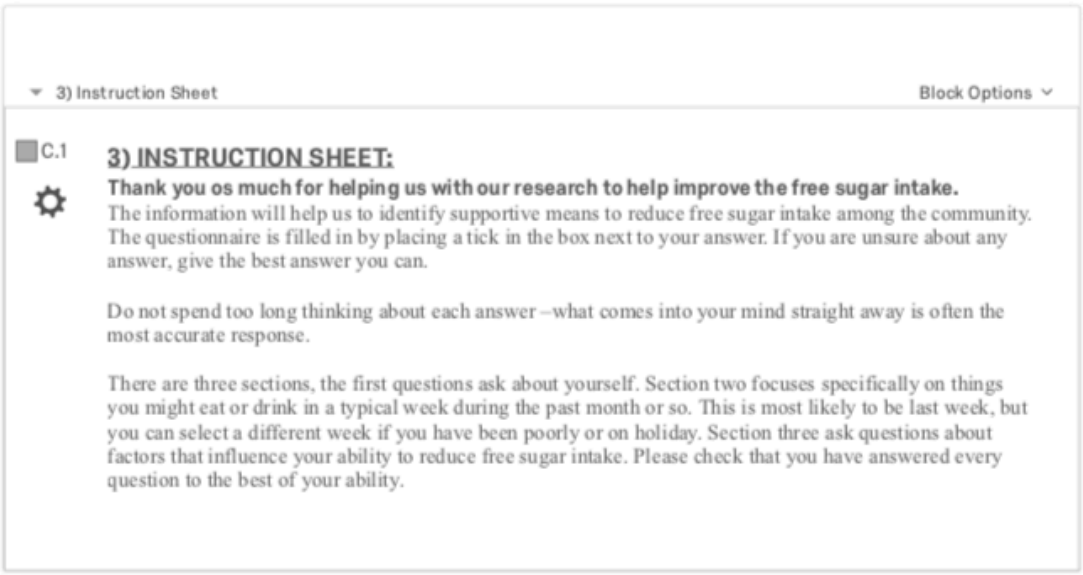
▸ 3) Instruction Sheet (1 Question) Block Options

▸ 4) Demographic Data (16 Questions) Block Options

▸ 5) Food and Drink Intake: (9 Questions) Block Options

▸ 6) Free Sugar Intake: (180 Questions) Block Options

13.9.5. Instruction Sheet



13.9.6. Actual Final online Survey

*What influences our sugar intake? Quantitative Study

Start of Block: 1) Information Sheet

A.1 **1) INFORMATION SHEET FOR PARTICIPANTS King's College London - Research Ethics MR/16/17-325 Title of study: What influences our sugar intake? A Quantitative Study**

We are pleased to invite you to take part in a research project. It is important for you to understand the reasons why we are undertaking for this research and what will be involved before you to decide to participate or not. Please take your time to read the following information carefully. Ask us if there is anything you need to have explained more clearly and we will be more than happy to assist you.

What is the purpose of the study?

The purpose of this study is to identify the potential facilitating factors and barriers which are associated with the behavioural change in reducing the intake of free sugar to less than 5% of the total energy intake among particular ethnic adults. In particular, we want to look at what influences the food you eat and what might influence people to reduce the amount of sugar in their diet.

Why have I been invited to take part?

We are asking you to take part. We are only asking you because previous research has shown that a particular group have the highest levels of sugar intake on average.

Do I have to take part?

It is up to you to decide whether to participate. If you do decide to participate, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason.

A.2 **What will happen to me if I take part?**

If you agree to take part in our study please select I agree option below.

Then, we will ask you to complete the consent form and fill online self-administration of a survey. The survey consist of three main elements: questions about yourself, about your daily diet related to sugar and what you feel would help you to make choices about the amount of sugar in your diet. **The time to complete the survey is approximately 110 minutes; you can save and continue later within one week from the initiation of filling the survey.**

Are there any incentives? As recognition of the time and effort involved in participation, we will offer you a £20 e-Amazon voucher at the end of the survey as our way of saying " Thank you". After completing the survey, you will be asked at the end of the survey to enter your email address which you have initially communicated with the researcher, so please make sure that you type your email properly.

What are the possible risks of taking part?

We believe that there are no risks or disadvantages to taking part, the only inconvenience is the time taken to answer the questions.

Will my taking part be kept confidential?

Absolutely, all information which is collected about you during the course of the research will be kept strictly confidential. The data will be protected by our University procedures. The information you give us will be kept on a password protected computer and the data destroyed at the end of the study. Our procedures for handling, processing, storage, and destruction of your data are compliant with the Data Protection Act 1998.

How is the project being funded?

This project is part of Said Al Rawahi's PhD studies at King's College London.

A.3 **What will happen to the results of the study?**

The results will be used part of an educational qualification for Said Al Rawahi as part of his PhD studies. We also hope to publish the research in academic journals. It will not be possible for any individual participant to be identified in any publication we produce. If you would like a summary of the findings of the study let us know and we will send you a summary at the end of our data analysis.

Who should I contact for further information? If you have any questions or require further information about this study, please contact Said Al Rawahi using the following contact details: Said.Al-Rawahi@kcl.ac.uk Telephone: +44 (0) 20 3 299 3481

What if I have further questions, or if something goes wrong?

Please contact Said Al Rawahi using the following contact details: Said.Al-Rawahi@kcl.ac.uk

The study ethical reference number is: MR/16/17-325 approved by [King's College London Research Ethics Minimal Risk Registration]. If you have any questions or complaints relating to the conduct of the research that have not been addressed satisfactorily by the research team please contact the BDM RESC (bdm@kcl.ac.uk)

Thank you for reading this information sheet and for considering taking part in this research

---

A.4 Please select one of the following:

- ○ I AGREE to participate in the study
- ○ I DISAGREE to participate in the study

Skip To: End of Survey If Please select one of the folloiwng: = I DISAGREE to participate in the study

End of Block: 1) Information Sheet

Start of Block: 2) Consent Form

B.1 **2) CONSENT FORM: Please complete this form after you have read the Information Sheet about the research.** **King's College London Research Ethics Number is MR/16/17-325** Thank you for considering taking part in this research. The Information Sheet explains the project to you before you agree to take part. If you have any questions arising from the Information Sheet, please contact the researcher (Said. Al-rawahi@kcl.ac.uk) before you decide whether to join in. I understand that it will be assumed that unticked/initialed boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study.

B.2 1

☐ I confirm that I understand that by ticking this box and each box below I am consenting to take part of this study.

B.3 2

☐ I confirm that I have read and understood the information sheet with Ethical Research number MR/16/17-325 for the above study. I have had the opportunity to consider the information and asked questions which have been answered satisfactorily.

B.4 3

☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. Furthermore, I understand that I will be able to withdraw my data up to 31 October 2017.

B.5 4

☐ I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.

B.6 5

☐ I understand that my information may be subject to review by responsible individuals from the College for monitoring and audit purposes.

B.7 6

☐ I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications.

B.8 7

☐ I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).

B.9 8

☐ I understand that the information I have submitted will be published as a report and I wish to receive a copy of it.

Page Break

End of Block: 2) Consent Form

Start of Block: 3) Instruction Sheet

C.1 **3) INSTRUCTION SHEET: Thank you os much for helping us with our research to help improve the free sugar intake.** The information will help us to identify supportive means to reduce free sugar intake among the community. The questionnaire is filled in by placing a tick in the box next to your answer. If you are unsure about any answer, give the best answer you can. Do not spend too long thinking about each answer –what comes into your mind straight away is often the most accurate response. There are three sections, the first questions ask about yourself. Section two focuses specifically on things you might eat or drink in a typical week during the past month or so. This is most likely to be last week, but you can select a different week if you have been poorly or on holiday. Section three ask questions about factors that influence your ability to reduce free sugar intake. Please check that you have answered every question to the best of your ability.

End of Block: 3) Instruction Sheet

Start of Block: 4) Demographic Data

D **4) ABOUT YOURSELF:**

D.1 Your nationality:

- ○ African (
- ○ American
- ○ Asian
- ○ Australian
- ○ British
- ○ Canadian
- ○ European
- ○ New Zealanders
- ○ South American
- ○ Irish

Skip To: End of Block If Your nationality: = American

Skip To: End of Block If Your nationality: = Canadian

Skip To: End of Block If Your nationality: = South American

Skip To: End of Block If Your nationality: = European

Skip To: End of Block If Your nationality: = African

Skip To: End of Block If Your nationality: = Asian

Skip To: End of Block If Your nationality: = Australian

Skip To: End of Block If Your nationality: = New Zealanders

Skip To: End of Block If Your nationality: = Irish

D.2 Your Ethnicity (This refer to where you where born not your passport):

- ○ White Scottish
- ○ White English
- ○ White Welsh
- ○ White Northern Irish
- ○ White British
- ○ White Irish
- ○ White Gypsy/traveller
- ○ Any other White Background
- ○ White and Black Caribbean
- ○ White and Black African
- ○ White and Asian
- ○ Indian
- ○ Pakistani
- ○ Bangladeshi
- ○ Chinese
- ○ Any other Asian background
- ○ African
- ○ Caribbean

- ○ Any other Black / African / Caribbean background
- ○ Arab
- ○ Any other ethnic group

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = White and Black Caribbean

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = White and Black African

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = White and Asian

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Indian

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Pakistani

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Bangladeshi

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Chinese

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Any other Asian background

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = African

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Caribbean

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Any other Black / African / Caribbean background

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Any other ethnic group

Skip To: End of Block If Your Ethnicity (This refer to where you where born not your passport): = Arab

D.3 Your health (tick all apply) :

- ☐ Diabetic
- ☐ Heart problem
- ☐ High blood pressure
- ☐ kidney disease
- ☐ HIV or AIDS (
- ☐ Eating disorders
- ☐ Mental disorders
- ☐ Blood disease
- ☐ Non of the above

Skip To: End of Block If Your health (tick all apply) : = Diabetic

Skip To: End of Block If Your health (tick all apply) : = Heart problem

Skip To: End of Block If Your health (tick all apply) : = High blood pressure

Skip To: End of Block If Your health (tick all apply) : = kidney disease

Skip To: End of Block If Your health (tick all apply) : = HIV or AIDS

Skip To: End of Block If Your health (tick all apply) : = Eating disorders

Skip To: End of Block If Your health (tick all apply) : = Mental disorders

Skip To: End of Block If Your health (tick all apply) : = Blood disease

D.4 Employment Status:

- ○ King's College London Staff
- ○ King's College London Student
- ○ A staff
- ○ A student
- ○ Retired
- ○ Unable to work

D.5 Your Age **(in years):**

▼ 18-22 …. ... 68- above

D.6 Your Gender:

- ○ Male.
- ○ Female.
- ○ Transgender
- ○ I would rather not to say.

D.7 Your Highest Qualification:

- ○ A Levels/Relevant Qualification
- ○ Secondary school/Diploma Level
- ○ Bachelor/ BDS/ Relevant Qualification
- ○ Masters (M.Sc., MDent, MD,.. etc)
- ○ Ph.D / Relevant Qualification
- ○ Others _____

D.8 Do you have any dental fillings?

- ○ Yes
- ○ No
- ○ I don't Know

Skip To: D.10 If Do you have any dental fillings? = No

Skip To: D.10 If Do you have any dental fillings? = I don't Know

D.9 If you have dental fillings when was the last time you had a dental filling?

- ○ Less than a year
- ○ A year ago
- ○ Two years ago
- ○ Three years ago
- ○ Four years ago
- ○ More than four years

D.10 Your height (please click on the following link for conversion: http://www.manuelsweb.com/ft_in_cm.htm):

Centimeters (1)	

D.11 Your weight (please click on the following link for conversion: http://www.stonestokilograms.com/):

Kilograms (1)	

D.12 Over the last 12 months, would you say that on the whole, your health has been:

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

D.13 Does your household own or rent the accommodation in which you live (**NOT** term accommodation)?

- ○ Owns Outright
- ○ Owns with a mortgage or loan
- ○ Pays part rent and part mortgage
- ○ Rents from council
- ○ Rents from a housing association
- ○ Rents from a private landlord
- ○ Accommodation is a residential home or student halls
- ○ Others _____

D.14 What is your social class? Please use The Great British class calculator to identify your social class. you can find the calculator in the link below. Follow the instruction to identify your social class. After you have identified your social class, please select the one which is appropriate to you one based on the calculator result. The Great British class calculator: http://www.bbc.co.uk/news/magazine-22000973

▼ Elite ..... Precariat

D.15 Where do you live?

▼ North East England ……. ... Northern Ireland

End of Block: 4) Demographic Data

Start of Block: 5) Food and Drink Intake:

E **5) YOUR FOOD AND DRINKS INTAKE:** The following questions ask about some foods & drinks **(that containing sugar)** you might have during a 'typical' week, over the past month or so. Do not be concerned if some things you eat or drink are not mentioned. *(Please only put one tick, but answer **EVERY** line)* (NB: the term sugar used in this section excludes natural sugar):

E.1 **5.1.Please tick how often you eat at least ONE portion of the following foods & drinks**: (a portion includes: a handful of grapes, an orange, a serving of carrots, a side salad, a slice of bread, a glass of pop).

	Never or less than once/ month	1-3 per month	once a week	2-4 times per week	5-6 times per week	Once a day	2-3 times per day	4-5 times per day	6+ per day
1) Dairy desserts e.g.Vanilla Yogurt or Rise pudding (125g carton) (1)	○	○	○	○	○	○	○	○	○
2) Salad cream mayonnaise (Tablespoon) (2)	○	○	○	○	○	○	○	○	○
3) French dressing (Tablespoon) (3)	○	○	○	○	○	○	○	○	○
4) Other salad dressing (Tablespoon) (4)	○	○	○	○	○	○	○	○	○
5) Sweet biscuits, chocolate, e.g. digestive (one) (5)	○	○	○	○	○	○	○	○	○

6) Sweet biscuits, plain, e.g. Nice, Ginger (one) (6)	○	○	○	○	○	○	○	○	○
7) Home baked cakes eg. Fruit, sponge (medium serving) (7)	○	○	○	○	○	○	○	○	○
8) Ready made cakes eg. Fruit, sponge (medium serving) (8)	○	○	○	○	○	○	○	○	○
9) Home baked buns, pastries eg. Scones, flapjacks (medium serving) (9)	○	○	○	○	○	○	○	○	○
10) Ready made buns, pastries eg. Croissants, doughnuts (medium serving) (10)	○	○	○	○	○	○	○	○	○

11) Home baked fruit pies, tarts, crumbles (medium serving) (11)	○	○	○	○	○	○	○	○	○
12) Ready made fruit pies, tarts, crumbles (medium serving) (12)	○	○	○	○	○	○	○	○	○
13) Home baked sponge puddings (medium serving) (13)	○	○	○	○	○	○	○	○	○
14) Ready made sponge puddings (medium serving) (14)	○	○	○	○	○	○	○	○	○
15) Milk puddings, eg. Rice , custard, trifle (medium serving) (15)	○	○	○	○	○	○	○	○	○
16) Ice cream, choc ices (medium serving) (16)	○	○	○	○	○	○	○	○	○

17) Chocolates, single or squares (medium serving) (17)	○	○	○	○	○	○	○	○	○
18) Chocolate snack bars eg. Mars, Crunchie (medium serving) (18)	○	○	○	○	○	○	○	○	○
19) Sweets, Toffees, mints (medium serving) (19)	○	○	○	○	○	○	○	○	○
20) Sugar added to tea, coffee, cereals (teaspoon) (20)	○	○	○	○	○	○	○	○	○
21) Crisps or other packet snacks, e.g. Wotsits (medium serving) (21)	○	○	○	○	○	○	○	○	○
22) Peanuts or other nuts (22)	○	○	○	○	○	○	○	○	○

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E.2 **5.2.Please tick how often you eat at least ONE portion of the following foods & drinks**: (a portion includes: a handful of grapes, an orange, a serving of carrots, a side salad, a slice of bread, a glass of pop).

	Never or less than once/ month	1-3 per month	once a week	2-4 times per week	5-6 times per week	Once a day	2-3 times per day	4-5 times per day	6+ per day
23) Vegetable soups (Bowl) (23)	○	○	○	○	○	○	○	○	○
24) Meat soups (Bowl) (24)	○	○	○	○	○	○	○	○	○
25) Sauces, eg. White sauce, cheese sauce, gravy (tablespoon) (25)	○	○	○	○	○	○	○	○	○
26) Tomato ketchup (tablespoon) (26)	○	○	○	○	○	○	○	○	○
27) Pickles, chutney (tablespoon) (27)	○	○	○	○	○	○	○	○	○
28) Marmite, Bovril (teaspoon) (28)	○	○	○	○	○	○	○	○	○

29) Jam, Marmalade, honey (teaspoon) (29)	○	○	○	○	○	○	○	○	○
30) Peanut butter (teaspoon) (30)	○	○	○	○	○	○	○	○	○
31) low fat yogurt, fromage frais (125 carton) (31)	○	○	○	○	○	○	○	○	○
32) low calorie, low fat salad cream (tablespoon) (32)	○	○	○	○	○	○	○	○	○
33) Cocoa, hot Chocolate (cup) (34)	○	○	○	○	○	○	○	○	○
34) Horlicks, Ovaltine (Cup) (35)	○	○	○	○	○	○	○	○	○
35) Wine (Glass) (36)	○	○	○	○	○	○	○	○	○

36) Beer, lager or cider (half pint) (37)	○	○	○	○	○	○	○	○	○
37) Port, Sherry, Vermouth, Liqueurs (glass) (38)	○	○	○	○	○	○	○	○	○
38) Spirits, e.g. gin, brandy, whisky, vodka (single) (39)	○	○	○	○	○	○	○	○	○
39) Low calorie or diet fizzy soft drinks (glass) (40)	○	○	○	○	○	○	○	○	○
40) Fizzy soft drinks e.g. Coca Cola, lemonade (glass) (41)	○	○	○	○	○	○	○	○	○
41) Pure fruit juice (100%) eg. Orange or apple juice. (glass) (42)	○	○	○	○	○	○	○	○	○

42) Fruit squash or cordial (glass) (43)	○	○	○	○	○	○	○	○	○
43) Tinned fruits (medium serving) (44)	○	○	○	○	○	○	○	○	○
44) Porridge, Ready Brek (One bowl) (45)	○	○	○	○	○	○	○	○	○

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E.3 **5.3. Are there any OTHER sugary foods or meals (e.g. granular or ready made meals) which you ate more than once a week (exclude sugar naturally available in fruits and milk)?**

- ○ Yes
- ○ No

Skip To: E.5 If 5.3. Are there any OTHER sugary foods or meals (e.g. granular or ready made meals) which you ate... = No

E.4 If Yes, please list below sugary food or meals:

	Food/ Meal	Usual serving Size	Number of time eaten each week
1 (1)			
2 (2)			
3 (3)			
4 (4)			
5 (5)			
6 (6)			
7 (10)			

E.5 **5.4.What milk(s) do you <u>usually</u> use or drink, such as in hot & cold drinks or on cereal?** (including tea, coffee, hot milk, milkshakes, or on cereal) **<u>(Tick all that apply)</u>**

- ☐ Whole / full-fat milk
- ☐ Semi-skimmed milk
- ☐ Skimmed milk
- ☐ Channel Islands
- ☐ Dried/ powered milk
- ☐ Soya (
- ☐ Rarely/never use milk
- ☐ Other (please write its name):

_____

E.6 **5.5.How much milk did you drink each day, including milk with tea, coffee, cereals etc ?**

- ○ None
- ○ Quarter of pint (Approx 142 ml)
- ○ Half a pint (Approx 284 ml)
- ○ Three quarters of a pint (Approx 426 ml)
- ○ One pint (Approx 568 ml)
- ○ More than one pint

E.7 **5.6. Did you usually eat breakfast cereal (excluding porridge and Ready Brek mentioned earlier)?**

- ○ Yes
- ○ No

Skip To: End of Block If 5.6. Did you usually eat breakfast cereal (excluding porridge and Ready Brek mentioned earlier)?... = No

E.8 **if Yes, please list below the breakfast cereals:**

	Brand e.g. Kellogg's	Types e.g. Cornflakes
1 (1)		
2 (2)		
3 (3)		
4 (4)		
5 (5)		

End of Block: 5) Food and Drink Intake:

Start of Block: 6) Free Sugar Intake:

FSQs 6) FREE SUGAR INTAKE: Please answer the following questions related to **free sugar intake**. **NB: The term "fruits" doesn't mean "fruit juices" in this survey. The term "sugar" used in the survey excludes sugar naturally present in fruits and milk.**

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K1) How aware are you of the types of food that cause tooth decay? (NB: In this question, the term "food" refers to any substance that you eat or drink)

- Extremely aware
- Very aware
- Moderately aware
- Neutral
- Slightly aware
- Little aware
- Not at all aware

K2) How aware are you of the types of food that are healthy for teeth? (NB: In this question, the term "food" refers to any substance that you eat or drink)

- ○ Extremely aware
- ○ Very aware
- ○ Moderately aware
- ○ Neutral
- ○ Slightly aware
- ○ Little aware
- ○ Not at all aware

K3) How aware are you of acidic foods?

- ○ Extremely aware
- ○ Very aware
- ○ Moderately aware
- ○ Neutral
- ○ Slightly aware
- ○ Little aware
- ○ Not at all aware

K4) How aware are you of the amount of sugar in the food that you eat and drink? NB: In this question The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Extremely aware
- ○ Very aware
- ○ Moderately aware
- ○ Neutral
- ○ Slightly aware
- ○ Little aware
- ○ Not at all aware

K5) How aware are you of when to eat sugary food in order to minimize the damage to my teeth? NB: In this question: The term "sugar" excludes sugar naturally

present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Extremely aware
- ○ Very aware
- ○ Moderately aware
- ○ Neutral
- ○ Slightly aware
- ○ Little aware
- ○ Not at all aware

K6) How aware are you of the daily sugar intake recommended by the World Health Organization? (NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk):

- ○ Extremely aware
- ○ Very aware
- ○ Moderately aware
- ○ Neutral
- ○ Slightly aware
- ○ Little aware
- ○ Not at all aware

K7) How aware are you of the calories in food that you eat and drink? (NB: In this question, the term "food" refers to any substance that you eat or drink)

- ○ Extremely aware
- ○ Very aware
- ○ Moderately aware
- ○ Neutral
- ○ Slightly aware
- ○ Little aware
- ○ Not at all aware

K8) To what extent do you understand the term "Free Sugar"?

- ○ I do not understand it at all
- ○ I have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K9) To what extent do you understand the term "Sugar-Free"?

- ○ I do not understand it at all
- ○ I have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K10) To what extent do you understand the term "Added Sugar"?

- ○ I do not understand it at all
- ○ I have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K11) To what extent do you understand the term "Hidden Sugar"?

- ○ I do not understand it at all
- ○ I have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K12) To what extent do you understand the relation between food calories and sugar content? NB: In this question, The term "sugar" excludes sugar naturally

present in fruits and milk The term "food" refers to any substance that you eat or drink

- ○ I do not understand it at all
- ○ I have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K13) To what extent do you understand the colour coding system (traffic light) in food packaging?

- ○ I do not understand it at all
- ○ I have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K14)To what extent do you understand the food labelling system in food packaging?

- ○ I do not understand it at all
- ○ have a low level of understanding
- ○ I have some understanding
- ○ Neutral
- ○ I have a moderate understanding
- ○ I have a high level of understanding
- ○ I have a thorough level of understanding

K15) To what extent are you in need of more information about the effects of sugar on your body? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K16) To what extent are you in need of more information about the effects of sugar on your teeth? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K17) To what extent are you in need of more information on the recommended daily sugar intake? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K18) To what extent are you in need of more information about the colour coding system (traffic light) for food packaging?

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K19) To what extent are you in need of more information about the hidden sugars in food? (NB: In this question, The term "sugar" excludes sugar naturally

present in fruits and milk The term "food" refers to any substance that you eat or drink

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K20) To what extent are you in need of more information about free sugars? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K21) To what extent are you in need of more information about the content of the food that you eat or drink? NB: In this question, The term "sugar" excludes sugar naturally present in fruits and milk The term "food" refers to any substance that you eat or drink

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K22) To what extent are you in need of more information about healthy eating?

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K23) To what extent are you in need of more information about the different types of sugar? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K24) To what extent are you in need of more information about the way in which exercise affects your sugar intake? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K25) To what extent are you in need of more information about how to achieve the recommended daily sugar intake in your daily diet? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K26) To what extent are you in need of more information about the sugar content of processed foods? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K27) To what extent are you in need of more information about the sugar content of ready meals? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

K28) To what extent are you in need of more information about the sugar content of restaurant meals? NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Somewhat in need
- ○ Less in need
- ○ Not at all in need

Page Break

PsyS1) How easily can you calculate your daily sugar intake when food labels are in **grams (e.g. sugar 20g)**?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS2) How easily can you calculate your daily sugar intake when food labels are in **percentages (e.g.** sugar 12%**)**?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS3) How often do you calculate your daily sugar intake?NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk)

- ○ Every day
- ○ 6-5 times a week
- ○ 4-3 times a week
- ○ 1-2 times a week
- ○ 3-2 times a month
- ○ Once a month
- ○ Never

PsyS4) What do you use to **calculate** your daily sugar intake?

NB: In this question, the term sugar excludes sugar naturally present in fruits and milk

- ○ Mobile Apps
- ○ Online or computer software
- ○ Notebook, manually
- ○ Others, please specify

_____

- ○ I don't calculate my daily sugar intake

PsyS5) How easily can you assess sugar content of food when labels are in **grams (e.g. sugar 20g)**?

(NB: In this question, The term "sugar" excludes sugar naturally present in fruits and milk The term "food" refers to any substance that you eat or drink

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS6) How easily can you assess the sugar content of food when labels are in **percentages (e.g. sugar 5%)**? NB: In this question, The term

"sugar" excludes sugar naturally present in fruits and milk The term "food" refers to any substance that you eat or drink

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS7) How often do you assess sugar content of food?

(NB: In this question, The term "sugar" used excludes sugar naturally present in fruits and milk The term "food" refers to any substance that you eat or drink

- ○ Every time I eat
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

PsyS8) How easily can you interpret food labels in **grams (e.g. sugar 20g)**?
(NB: In this question, the term "food" refers to any substance that you eat or drink)

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS9) How easily can you interpret food labels in **percentages (e.g. sugar 5%)**?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS10) How often do you interpret the food labelling?

- ○ Every time I eat
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

PsyS11) How easily can you interpret the colour coding (traffic light system)?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PsyS12) How often do you interpret the colour coding (traffic light system)?

- ○ Every time I eat
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

PsyS13) For each of these different foods and meals, please indicate whether you do each skill:**(tick all apply)**

	Calculate daily sugar intake	Assess sugar content	Interpret food labelling	Interpret color coding	Not applicable
Restaurant cooked meals (11)	☐	☐	☐	☐	☐
Ready made meals (e.g. a sandwich or Lasagne from a store) (14)	☐	☐	☐	☐	☐
Home made meals (12)	☐	☐	☐	☐	☐
Processed foods (e.g. breakfast cereals; tomato ketchup) (13)	☐	☐	☐	☐	☐
Sugary foods (e.g. sweets, candy) (19)	☐	☐	☐	☐	☐
Sugary drinks (e.g. soft drinks, squash juice) (17)	☐	☐	☐	☐	☐
Fruit juice (21)	☐	☐	☐	☐	☐

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MADP1) How often do you choose snack foods with a low sugar content?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP2) How often do you choose meals with a low sugar content?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP3) How often do you choose drinks with a low sugar content?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk)

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP4) How often do you choose snack foods with a high sugar content?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP5) How often do you choose meals with a high sugar content?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP6) How often do you choose drinks with a high sugar content?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP7) How often do you choose low calories snack foods?

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP8) How often do you choose low calories meals?

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP9) How often do you choose low calories drinks?

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP10) How often do you choose snack foods with a high sugar content that have been reduced in price?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP11) How often do you choose meals with a high sugar content that have been reduced in price?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP12) How often do you choose drinks with a high sugar content that have been reduced in price?

(NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Always
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP13)How trustworthy do you think the food labelling system as a source of information for food content?

- ○ Very untrustworthy
- ○ Untrustworthy
- ○ Somewhat untrustworthy
- ○ Neither untrustworthy nor trustworthy
- ○ Somewhat trustworthy
- ○ Trustworthy
- ○ Very trustworthy

MADP14)How trustworthy do you think the colour coding system (traffic light label system) as a source of information for food content?

- ○ Very untrustworthy
- ○ Untrustworthy
- ○ Somewhat untrustworthy
- ○ Neither untrustworthy nor trustworthy
- ○ Somewhat trustworthy
- ○ Trustworthy
- ○ Very trustworthy

MADP15) To what extent do you recall the current advice on sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ I do not recall
- ○ I have low level of recall
- ○ I have slight level of recall
- ○ Neutral
- ○ I have moderate level of recall
- ○ I have very well level of recall
- ○ I have extreme level of recall

MADP16) To what extent do you recall the amount of sugar in food?

NB: In this question,

The term "sugar" excludes sugar naturally present in fruits and milk.

The term "food" refers to any substance that you eat or drink.

- ○ I do not recall
- ○ I have low level of recall
- ○ I have slight level of recall
- ○ Neutral
- ○ I have moderate level of recall
- ○ I have very well level of recall
- ○ I have extreme level of recall

MADP17) To what extent do you agree or disagree that the colour-coding system (traffic-light labelling) can provide a quick comparison between two products?

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

MADP18) To what extent do you agree or disagree that the colour-coding system (traffic-light labelling) can provide a quick selection between two products?

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

MADP19) To what extent do you agree or disagree that the colour-coding system (traffic-light labelling) can attract your attention when selecting foods?
NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Strongly agree
- ○ Agree (4)
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

MADP20) To what extent do you agree or disagree that the colour-coding system (traffic-light labelling) can help you to distinguish between healthy and unhealthy

foods?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

MADP21) How often do you look at the nutritional value of the foods you buy?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Every time
- ○ Usually, about 90% of the the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time (36)
- ○ Never (23)

MADP22) How often do you pay attention to your sugar intake when you eat or drink?

NB: In this section, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Every time
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

MADP23) How often do you pay attention to the following contents on food labelling?

	Every time	Usually, about 90% of the time	Frequently, about 70% of the time	Sometimes, about 50% of the time	Occasionally, about 30% of the time	Rarely, less than 10% of the time	Never
Calories (14)	○	○	○	○	○	○	○
Fat (19)	○	○	○	○	○	○	○
Saturated fat (17)	○	○	○	○	○	○	○
Sugar (21)	○	○	○	○	○	○	○

MADP24)How often do you pay attention to the colour-coding system (traffic-light labelling) when purchasing food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Every time
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never (

MADP25) How important to you is the effect of sugar consumption on the following:
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

	Extremely important	Very important	Moderately important	Neutral	Slightly important	Low important	Not at all important
Your body weight (12)	○	○	○	○	○	○	○
Your general health (e.g. getting diabetes) (22)	○	○	○	○	○	○	○
Your teeth (13)	○	○	○	○	○	○	○

MADP26) How high a priority to you is the taste of food over health concerns?
NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Much higher priority
- ○ Higher priority
- ○ Moderately higher priority
- ○ Equal priority
- ○ Moderately lower priority
- ○ Lower priority
- ○ Much lower priority

MADP27)How often do you pay attention to your sugar intake when buying the following:

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

	Eevey Time	Usually, about 90% of the time	Frequently, about 70% of the time	Sometimes, about 50% of the time	Occasionally, about 30% of the time	Rarely, less than 10% of the time	Never
Processed foods (21)	○	○	○	○	○	○	○
Sugary foods (e.g. sweets) (14)	○	○	○	○	○	○	○
Sugary drinks (e.g. fizzy drinks , fruit juice) (19)	○	○	○	○	○	○	○
Ready meals (17)	○	○	○	○	○	○	○
Restaurant meals (22)	○	○	○	○	○	○	○

MADP28) To what extent would your attention be attracted to the following methods of identifying foods with a high sugar content?

NB: In this question, The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very attracted	Attracted	Somewhat attracted	Neither attracted nor unattracted	Somewhat unattracted	Unattracted	Very unattracted
A picture of tooth decay on food products (21)	○	○	○	○	○	○	○
Colour coding system (14)	○	○	○	○	○	○	○
Food labelling in the form of grams (19)	○	○	○	○	○	○	○
Food labelling in the form of percentage (17)	○	○	○	○	○	○	○

MADP29) How high a priority for you is the frequency of having sugar over the amount of sugar in food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Much higher priority
- ○ Higher priority
- ○ Moderately higher priority
- ○ Equal priority
- ○ Moderately lower priority
- ○ Lower priority
- ○ Much lower priority

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BR1) How often do you plan your daily sugar intake?
(NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Every day
- ○ 6-5 times per week
- ○ 4-3 times per week
- ○ 1-2 times per week
- ○ 3-2 times per month
- ○ Once per month
- ○ Not at all

BR2) How often do you select a small portion of sugary food when a large portion is available?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Every time
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

BR3) Please rank the following in order of importance when eating food.

NB: In this question, the term "food" refers to any substance that you eat or drink.

_____ Taking care of your teeth

_____ Taking care of your body weight and fitness

_____ Taking care of your general health (e.g. avoiding diabetes)

BR4) Please rank the following in order of priority when buying food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

_____ Processed foods

_____ Whole/ fresh foods

BR5) How often do you look at food labelling before selecting food?

NB: In this question, the term "food" refers to any substance that you eat or drink

- ○ Every time
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

Skip To: BR7 If BR5) How often do you look at food labelling before selecting food? NB: In this question, the te... = Never

BR6) Please rank the following in order of priority when you look at food labelling?

NB: In this question, the term "food" refers to any substance that you eat or drink.

_____ Food calorie

_____ Fat/saturated fat

_____ Salt

_____ Sugar

BR7) To what extent are you in need of a system to monitor your food intake?NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Slightly in need
- ○ Less in need
- ○ Not at all in need

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PhyS1) How often do select healthy food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Every time
- ○ Usually, about 90% of the time
- ○ Frequently, about 70% of the time
- ○ Sometimes, about 50% of the time
- ○ Occasionally, about 30% of the time
- ○ Rarely, less than 10% of the time
- ○ Never

PhyS2) How easy or difficult do you find the preparation of healthy food for cooking?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PhyS3) How easy or difficult is it to find healthy food products at a cheap price?
NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PhyS4) How easy or difficult is it to find the sugar content of food using the colour-coding (traffic-light) system?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PhyS5) How easy or difficult is it to find the sugar content of food on food labelling?
NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

PhyS6) To what extent are you in need of cooking skills?

- ○ Very much in need
- ○ Much in need
- ○ Moderately in need
- ○ Neutral
- ○ Slightly in need
- ○ Less in need
- ○ Not at all in need

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SI1) To what extent are/were your parents influential in reducing your sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI2) To what extent are/were your parents' beliefs/attitudes about sugar intake influential on your belief/ attitude?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and

milk. _

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI3) To what extent is your partner influential in reducing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI4) To what extent are your relatives Influential in reducing your sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI5) To what extent are your friends influential in reducing your sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI6) To what extent are other cultures influential in reducing your sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI7) To what extent is your culture influential in reducing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI8) To what extent are health professionals influential in reducing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI19) To what extent are your friends, relatives or partner's experience of ill-health influential in reducing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SI10) How likely or unlikely do you think it is that parents would allow their children to buy sweets with a picture of tooth decay on the packet?

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ unlikely
- ○ Extremely unlikely

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ECR1) To what extent are advertisements between television programmes influential in reducing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

ECR2) To what extent is the arrangement of sugary food at the entrance of stores influential in increasing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

ECR3) To what extent are promotions (sales) related to sugary food influential in increasing your sugar intake?

NB: In this question, **the term "sugar" excludes sugar naturally present in**

fruits and milk. the term "food" refers to any substance that you eat or drink).

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

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ECR4) How expensive or inexpensive do you consider the following food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

	Very expensive	Expensive	Somewhat expensive	Neither expensive nor inexpensive	Somewhat inexpensive	Inexpensive	Very inexpensive
Restaurants meals (exclude fast foods) (1)	○	○	○	○	○	○	○
Fast-food restaurant meals (13)	○	○	○	○	○	○	○
Healthy food (e.g. vegetables) (2)	○	○	○	○	○	○	○
Fizzy drinks (3)	○	○	○	○	○	○	○
Fruit juice (ready made) (4)	○	○	○	○	○	○	○

ECR5) How likely or unlikely are you to consume the following food in high quantities when you are ill? NB: In this question, the term "sugar" excludes

sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

	Extremely Likely	Likely	Somewhat likely	Neither likely nor unlikely	Somewhat unlikely	Unlikely	Extremely unlikely
Energising drinks added sugar (e.g. Lucozade) (1)	○	○	○	○	○	○	○
Energising drinks no added sugar (e.g. Lucozade) (17)	○	○	○	○	○	○	○
Fruit juice (18)	○	○	○	○	○	○	○
Fizzy drinks (3)	○	○	○	○	○	○	○
Sweet food (e.g. pudding) (2)	○	○	○	○	○	○	○

ECR6) How likely or unlikely are you to get free healthy food (e.g. fruits) at your workplace?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

ECR7) How concerned are you about cost when you buy food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Extermely concerned
- ○ Very concerned
- ○ Moderately Concerned
- ○ Neutral
- ○ Slightly concerned
- ○ Less concerned
- ○ Not at all Concerned

ECR8) How likely or unlikely are you to eat sugary food if it is available?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

ECR9) How easy or difficult is it for you get access to sugary food?
NB: In this question, the term "food" refers to any substance that you eat or drink.

the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

ECR10) How easy or difficult is it for you to access to healthy food?
NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy not difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

ECR11) How easy or difficult is it for you to determine the sugar content in restaurant food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

ECR12) To what extent is social media (e.g. Facebook) useful as a source of information about sugary foods?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Extremely useful
- ○ Very Useful
- ○ Moderately useful
- ○ Neutral
- ○ Slightly useful
- ○ less useful
- ○ Not at all useful

ECR13) How likely or unlikely are you to buy sugary food when you feel hungry in stores?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

ECR14) To what extent do you agree or disagree that there are too many foods with too much with too high a sugar content?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

ECR15) How likely or unlikely do you think it is that sugary food products have the following labels?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

	Extremely Likely	Likely	Somewhat likely	Neither likely nor unlikely	Somewhat unlikely	Unlikely	Extremely unlikely
Sugar content (1)	○	○	○	○	○	○	○
Colour coding system (17)	○	○	○	○	○	○	○

ECR16) How understandable is the size of serving on food packaging?

- ○ Extermely understandable
- ○ Very understandable
- ○ Moderately understandable
- ○ Neutral
- ○ Slightly understandable
- ○ Less understandable
- ○ Not at all understandable

ECR17) How readable do you find the font size of food labels?

- ○ Extremely readable
- ○ Very readable
- ○ Moderately readable
- ○ Neutral
- ○ Slightly readable
- ○ Less readable
- ○ Not at all readable

ECR18) How satisfied or dissatisfied are you when food labels mention sugar content of food products per number of grams (e.g. per 100g) without mentioning sugar content of the whole weight of the food products?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Very satisfied
- ○ satisfied
- ○ Somewhat satisfied
- ○ Neither satisfied nor dissatisfied
- ○ Somewhat dissatisfied
- ○ dissatisfied
- ○ Very dissatisfied

ECR19) To what extent are you exposed to media campaigns about reducing sugar consumption?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and

milk.

- ○ Extremely exposed
- ○ Very exposed
- ○ Moderately exposed
- ○ Neutral
- ○ Somewhat exposed
- ○ Less exposed
- ○ Not at all exposed

ECR20) How likely or unlikely are you to see educational programmes about sugar in food on television?
NB: in this question, the term "sugar" excludes sugar naturally present in fruits and

milk

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

ECR21) How helpful or unhelpful to you are fitness or diet apps in reducing your sugar intake?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very helpful
- ○ Helpful
- ○ Somewhat helpful
- ○ Neither helpful nor unhelpful
- ○ Somewhat unhelpful
- ○ Unhelpful
- ○ Very unhelpful

ECR22) How likely or unlikely are you to use apps that can count the sugar content of food?

NB: in this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

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ECR23) Based on your experience, please indicate which of the following methods of food labelling help you to reduce sugar intake: Please tick all that apply

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ☐ Percentages (e.g. 20%) (28)
- ☐ Grams (e.g. 20g) (29)
- ☐ Colour-coding (traffic-light system) (30)
- ☐ Others (please state) (31)

_____

ECR24) To what extent do you agree or disagree with the following suggestions for the food labelling system:

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
The text of sugar labelling on food should be bold or in large font size. (26)	○	○	○	○	○	○	○
The recommended daily intake of sugar and the sugar content of food products should be stated on food labelling. (32)	○	○	○	○	○	○	○
The total amount of sugar in food products should be labelled rather than per serving only. (33)	○	○	○	○	○	○	○

The labelling of sugar should be a simple colour scheme. (34)	○	○	○	○	○	○	○
The labelling of sugar should be visible on the front of food products. (35)	○	○	○	○	○	○	○

ECR25) To what extent do you agree or disagree with the following suggestions for the food labelling system?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Amount of sugar should be clearly stated. (27)	○	○	○	○	○	○	○
The daily recommended sugar intake for men and women should be stated. (28)	○	○	○	○	○	○	○
The amount of sugar in foods should be expressed in percentages only. (48)	○	○	○	○	○	○	○
The amount of sugar in foods should be expressed in grams only. (49)	○	○	○	○	○	○	○

The amount of sugar in foods should be expressed in both percentages and grams. (50)	○	○	○	○	○	○	○

ECR26) To what extent do you agree or disagree with the following suggestions for the colour-coding (traffic-light) system?

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
The system needs to be publicised and advertised e.g. on television. (36)	○	○	○	○	○	○	○
The system needs to be more obvious to the eye. (37)	○	○	○	○	○	○	○

ECR27) To what extent do you agree or disagree with the suggestions that a picture of tooth decay should be put on the packaging of sugary food?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

ECR28) To what extent do you agree or disagree with the following suggestions for the education about sugar in food?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree (14)	Strongly disagree
Information should be advertised in the internet, buses etc. (39)	○	○	○	○	○	○	○
Need more educational campaigns about sugar consumption. (40)	○	○	○	○	○	○	○
GP's should provide information about sugar. (41)	○	○	○	○	○	○	○
Need nutritional classes in the workplace. (42)	○	○	○	○	○	○	○

ECR29) To what extent do you agree or disagree with the suggestions that posters about the sugar content of food should be posted beside the food in supermarkets and shops?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk. the term "food" refers to any substance that you eat or drink.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

ECR30) To what extent do you agree or disagree with the suggestions that the prices of health food (e.g. fruits and vegetables) should be reduced?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

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SPRI1) How influential is your professional identity or role in increasing your sugar intake?

NB: In this question: Professional identity means those aspects of your identity that have developed as a result of your work activities. The term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ less influential
- ○ Not at all influential

SPRI2) How influential is your social identity or role in increasing your sugar intake?

NB: In this question: Social Identity means those aspects of your identity that arise

from your membership of a group e.g. friends, family or society. The term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SPRI3) How influential is your personality in increasing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SPRI4) How influential is your political identity or role in increasing your sugar intake?

NB: In this question: **Political identity means those aspects of your identity that**

arise from your membership of a group such as a political party. The term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SPRI15) How influential is your social class in increasing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely influential
- ○ Very influential
- ○ Moderately influential
- ○ Neutral
- ○ Slightly influential
- ○ Less influential
- ○ Not at all influential

SPRI16) How influential are the following social experiences in reducing your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

	Extremely influential	Very influential	Moderately influential	Neutral	Slightly influential	Less influential	Not at all influential
Your previous sugar consumption (11)	○	○	○	○	○	○	○
Your previous healthy cooking (17)	○	○	○	○	○	○	○

SPRI17) To what extent do you agree that eating sugar is an essential part of human nature?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disgree
- ○ Strongly diagree

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BACa1) How easy or difficult is it for you to measure the amount of sugar when cooking a meal (exclude microwaving meals)?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ difficult
- ○ Very difficult

BACa2) How easy or difficult is it for you to quantify your sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa3 BACa3) How easy or difficult is it for you to find out the sugar content in food from the food labels?

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat Easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very Difficult

BACa4 BACa4) How easy or difficult is it for you to find out the sugar content in food from the colour-coding (traffic-light) system?

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very Difficult

BACa5) How easy or difficult is it for you to understand food labelling when it is expressed as a percentages (e.g. 15%) only?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa6)How easy or difficult is it for you to understand food labelling when it is expressed in grams (e.g. 20g) only?

- ○ Very easy
- ○ Easy
- ○ Somewhat Easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa7) How easy or difficult is it for you to understand food labelling when it is expressed in both percentages and grams?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa8) How easy or difficult is it for you to find the sugar content in food from the packaging?

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa9) How easy or difficult is it for you to calculate your amount of sugar intake per day?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very Difficult

BACa10) How easy or difficult is it for you to control your sugar intake?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa11) How easy or difficult is it for you to reduce your intake of sweet snacks?

- ○ Very easy
- ○ Easy
- ○ Somewhat Easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa12) How easy or difficult is it for you to get sweets?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa13) How easy or difficult is it for you to determine the sugar content of ready meals?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa14) How easy or difficult is it for you to control the influence of advertisements?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult

BACa15) How easy or difficult is it for you to read food labels?

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Neither easy nor difficult
- ○ Somewhat difficult
- ○ Difficult
- ○ Very Difficult

BACa16) How careful are you about your food choices?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Extremely careful
- ○ Very careful
- ○ Moderately careful
- ○ Neutral
- ○ Slightly careful
- ○ Less careful
- ○ Not careful at all

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O1) How sure or unsure are you that the colour-coding (traffic-light) system will cause the following effects?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

	Very sure	Sure	Somewhat sure	Neither sure nor unsure	Somewhat unsure	Unsure	Very unsure
I will select food with low sugar (2)	○	○	○	○	○	○	○
It will attract my attention (3)	○	○	○	○	○	○	○
It will facilitate food comparison. (4)	○	○	○	○	○	○	○

O2) How sure or unsure are you that the following systems would help you to reduce your sugar intake?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

	Very sure	Sure	Somewhat sure	Neither sure nor unsure	Somewhat unsure	Unsure	Very unsure
Food labelling system (2)	○	○	○	○	○	○	○
Colour-coding (traffic-light) system (3)	○	○	○	○	○	○	○
A picture of tooth decay on sugary food (5)	○	○	○	○	○	○	○
Education about sugar consumption (6)	○	○	○	○	○	○	○
A sugar tax on sugary food (7)	○	○	○	○	○	○	○

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I1) How often are you **intend** to do the following when you eat?

NB: In this question: The term "sugar" used in this section excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Every time	Usually, 90% of the time	Frequently, 70% of the time	Sometime, 50% of the time	Occasionally, 30% of the time	Rarely, 10% of the time	Never
Choose sugary food (1)	○	○	○	○	○	○	○
Choose food low sugar content (2)	○	○	○	○	○	○	○
Choose unhealthy food. (5)	○	○	○	○	○	○	○
Choose healthy food (3)	○	○	○	○	○	○	○

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G1) How important are the following goals to you?

	Extremely important	Very important	Moderately important	Neutral	Slightly important	Less important	Not at all important
Losing weight (1)	○	○	○	○	○	○	○
Gaining weight (3)	○	○	○	○	○	○	○
Getting in good physical shape. (2)	○	○	○	○	○	○	○
Maintaining healthy teeth. (4)	○	○	○	○	○	○	○

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R1) How likely or unlikely is the colour-coding (traffic- light) system to reinforce your selection of healthy food?

NB: In this question, the term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

R2) How likely or unlikely are exercise labels on food to reinforce your behaviour such as increase sugar reduction?

NB: In this question: The term "sugar" excludes sugar naturally present

in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

R3) How likely or unlikely is education about sugar to reinforce your decisions about reducing sugar intake?

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

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MSPRI1) How likely or unlikely is it that your sugar intake will increase during your annual leaves (holidays)?

NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

MSPRI2) How often do you do the following:

NB: In this question, the term sugar used in this section excludes sugar naturally present in fruits and milk.

	Every day	6-5 times per week	4-3 times per week	2-1 times per week	3-2 times per month	Once per month	Not at all
Cook food (exclude microwaving) (11)	○	○	○	○	○	○	○
Buy sweets (17)	○	○	○	○	○	○	○
Crave sweets (12)	○	○	○	○	○	○	○
Share sugary food with others (13)	○	○	○	○	○	○	○

MSPRI3) to what extent is it true or untrue that your sugar intake is the result of a habit?

- ○ Very true
- ○ True
- ○ Somewhat true
- ○ Neutral
- ○ Somewhat untrue
- ○ Untrue
- ○ Very untrue

MSPRI4) How likely or unlikely do you think it is that childhood education about sugar in food will result in the development of good habits related to a reduced sugar?
NB: In this question, the term "sugar" excludes sugar naturally present in fruits and milk.

- ○ Extremely likely
- ○ Likely
- ○ Somewhat likely
- ○ Neither likely nor unlikely
- ○ Somewhat unlikely
- ○ Unlikely
- ○ Extremely unlikely

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E1) How often do you have the following feelings when you eat or drink?

	Every time	Usually, about 90% of the time	Frequently, about 70% of the time	Sometimes, about 50% of the time	Occasionally, about 30% of the time	Rarely, less than 10% of the time	Never
Want sweet tasty food (11)	○	○	○	○	○	○	○
Crave sweets (12)	○	○	○	○	○	○	○
Crave fizzy drinks. (13)	○	○	○	○	○	○	○

Page Break

E2) To what extent do you like or dislike the following? NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very much like	Like	Somewhat like)	Neither like or dislike	Somewhat dislike	Dislike	Very much dislike
Fruit with a main meal. (6)	○	○	○	○	○	○	○
Fruits as snacks (7)	○	○	○	○	○	○	○
Sugary food as snacks (12)	○	○	○	○	○	○	○
Drinking fizzy drinks (10)	○	○	○	○	○	○	○
Cheap sugary food (11)	○	○	○	○	○	○	○

E3) To what extent do you like or dislike the taste of the following food?

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very much like	Like	Somewhat like	Neither like or dislike	Somewhat dislike	Dislike	Very much like
Hot drinks without sugar. (3)	○	○	○	○	○	○	○
Cold drinks without sugar . (4)	○	○	○	○	○	○	○
Fruits. (5)	○	○	○	○	○	○	○
Sugary food (2)	○	○	○	○	○	○	○

E4) To what extent is it true or untrue that you feel guilty after eating sugary snacks?

- ○ Very true
- ○ true
- ○ Somewhat true
- ○ Neutral
- ○ Somewhat untrue
- ○ Untrue
- ○ Very Untrue

E5) To what extent is it true or untrue that you have no interest in counting the sugar content of food? NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

- ○ Very true
- ○ true
- ○ Somewhat true
- ○ Neutral
- ○ Somewhat untrue
- ○ Untrue
- ○ Very Untrue

E6) To what extent is it true or untrue that you have had a bad experience with fitness apps?

- ○ Very true
- ○ true
- ○ Somewhat true
- ○ Neutral
- ○ Somewhat untrue
- ○ Untrue
- ○ Very Untrue

Q229 E7) To what extent is it true or untrue that your treats are sugary food?

- ○ Very true
- ○ true
- ○ Somewhat true
- ○ Neutral
- ○ Somewhat untrue
- ○ Untrue
- ○ Very Untrue

E8) To what extent is it true or untrue that you would have the following feelings if you see a picture of tooth decay on sugary food?

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Afraid of getting tooth decay. (15)	○	○	○	○	○	○	○
Annoyed. (16)	○	○	○	○	○	○	○
Guilty. (17)	○	○	○	○	○	○	○
Feel that you have no control over your sugar intake. (18)	○	○	○	○	○	○	○
Horrified (19)	○	○	○	○	○	○	○

Page Break

BACo1) To what extent is it true or untrue that you have the following beliefs:

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Sweets are healthy. (1)	○	○	○	○	○	○	○
Low calorie food is healthy for teeth (32)	○	○	○	○	○	○	○
The natural sugar in fruits and vegetables is healthy. (2)	○	○	○	○	○	○	○
Cooking food has healthy consequences. (3)	○	○	○	○	○	○	○
Natural fruits with high sugar is bad for teeth. (19)	○	○	○	○	○	○	○

Page Break

BACo2) To what extent is it true or untrue that you have the following beliefs:
NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Drinking a lot of fruit juice reduces illness. (8)	○	○	○	○	○	○	○
Drinking fizzy drink has positive consequences e.g. boost energy. (9)	○	○	○	○	○	○	○
Having sugar in moderation (based on my needs) is okay. (11)	○	○	○	○	○	○	○
Low-sugar food tastes bad. (13)	○	○	○	○	○	○	○
Only high-fat and high-calorie foods are bad for health. (14)	○	○	○	○	○	○	○

BACo3) To what extent is it true or untrue that you have the following beliefs:
NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Exercise helps to consume less sweet food. (4)	○	○	○	○	○	○	○
Doing exercise without reducing sugar intake is healthy. (5)	○	○	○	○	○	○	○
Consuming sugar is fine as long as I do exercise. (7)	○	○	○	○	○	○	○
Exercise causes an increase in snacking sugary food. (12)	○	○	○	○	○	○	○

BACo4) To what extent is it true or untrue that you have the following beliefs:

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Food labelling that gives the grams and percentages of sugar is helpful when selecting ready meals. (18)	○	○	○	○	○	○	○
Food labelling giving the grams and percentages of sugar is helpful in reducing sugar intake. (52)	○	○	○	○	○	○	○
Food labelling giving the grams of sugar is helpful in reducing sugar intake. (35)	○	○	○	○	○	○	○

Food labelling giving the percentage of sugar is helpful in reducing sugar intake. (53)	○	○	○	○	○	○	○

Page Break

BACo5) To what extent is it true or untrue that you have the following beliefs:
NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Clear (easy to interpret) labelling will encourage you to set a plan for daily sugar intake. (48)	○	○	○	○	○	○	○
Obvious (visible) labelling will encourage you to set a plan for daily sugar intake. (54)	○	○	○	○	○	○	○

Clear (easy to interpret) food labelling will make you think carefully about food with high-sugar content. (49)	○	○	○	○	○	○	○
Obvious (visible) labelling will make individuals think carefully about food with high-sugar content. (55)	○	○	○	○	○	○	○

Page Break

BACo6) To what extent is it true or untrue that you have the following beliefs: NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue of	Very untrue
The percentage of individual 's recommended daily intake will be useful in helping you to think about the food before buying it. (50)	○	○	○	○	○	○	○
Food labelling packages giving the sugar amounts against the recommended level of intake will result in the selection of food with low-sugar content. (51)	○	○	○	○	○	○	○

Food labelling giving the grams and percentages is helpful in identifying with the content of sugary food (e.g. sweets). (19)	○	○	○	○	○	○	○
Presenting sugar content in percentages or grams is helpful in reducing sugar intake when comparing two products together. (20)	○	○	○	○	○	○	○

Page Break

BACo7) To what extent is it true or untrue that you have the following beliefs:

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Colour-coding system leads to a greater awareness of food choice. (25)	○	○	○	○	○	○	○
Colour-coding system helps to reduce sugar intake for unhealthy people (e.g. diabetics) (36)	○	○	○	○	○	○	○
Colour-coding system will reduce sugar intake for a average healthy person. (26)	○	○	○	○	○	○	○

Colour-coding system is <u>not</u> useful when comparing two products that have the same sugar content. (37)	○	○	○	○	○	○	○
Colour-coding system is a very poor way of presenting information. (27)	○	○	○	○	○	○	○

Page Break

BACo8) To what extent is it true or untrue that you have the following beliefs:
NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Colour-coding system leads to the selection of low-sugar food by attracting your attention. (22)	○	○	○	○	○	○	○
Colour-coding system leads to the selection of low-sugar food by allowing comparison between food products. (23)	○	○	○	○	○	○	○

Colour-coding system leads to the selection of low-sugar food by allowing an assessment the content of the products. (24)	○	○	○	○	○	○	○
Colour-coding system is useful when comparing two products that have the same sugar content. (47)	○	○	○	○	○	○	○

Page Break

BACo9) To what extent is it true or untrue that you have the following beliefs: NB: In this question: The term "sugar" excludes sugar naturally present in fruits and

milk. The term "food" refers to any substance that you eat or drink. **The exercise label is food labels which state the amount of exercise to burn off energy.**

	Very true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Exercise label on food leads to thinking about sugar consumption before eating. (28)	○	○	○	○	○	○	○
Exercise label increases awareness of how much exercise you need to do to burn off energy. (29)	○	○	○	○	○	○	○
Exercise label helps to control the intake of sweet snacks. (30)	○	○	○	○	○	○	○
Exercise label encourages healthy meals. (31)	○	○	○	○	○	○	○

Exercise label will influence the choices of a healthy person. (32)	○	○	○	○	○	○	○
Exercise label is useful for people who are not performing exercise. (34)	○	○	○	○	○	○	○

Page Break

BACo10) To what extent is it true or untrue that you have the following beliefs:

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Vey true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Sugar or food taxes would help the nation to reduce its sugar intake. (47)	○	○	○	○	○	○	○
Sugar or food taxes would reduce the frequency of sugar intake. (48)	○	○	○	○	○	○	○
A high-sugar tax would reduce sugar intake only. (49)	○	○	○	○	○	○	○
A high-sugar tax would have no effect on people with low sugar consumption. (50)	○	○	○	○	○	○	○

A high-sugar tax has no effect on reducing sugar intake. (51)	○	○	○	○	○	○	○
A high sugar tax would lead to the selection of the cheapest sugary food. (52)	○	○	○	○	○	○	○

Page Break

BACo11) To what extent is it true or untrue that you have the following beliefs: NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Vey true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Natural fruits containing high levels of sugar is bad for teeth. (57)	○	○	○	○	○	○	○
Television adverts promoting low sugar intake will help to reduce sugar intake. (60)	○	○	○	○	○	○	○
Sugar consumption can be addictive. (61)	○	○	○	○	○	○	○

Page Break

BACo12) To what extent is it true or untrue that you have the following beliefs:
NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Vey true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Education about sugar in food will lead to positive results for your body and health. (43)	○	○	○	○	○	○	○
Education about sugar in food enables you to make a judgement about your sugar intake. (44)	○	○	○	○	○	○	○
Education about sugar in food helps you to decide on healthy food. (45)	○	○	○	○	○	○	○

Education about sugar in food has no effect on you. (46)	○	○	○	○	○	○	○

Page Break

BACo13) To what extent is it true or untrue that you have the following beliefs: NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Vey true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Placing a picture of tooth decay on food packaging would have no influence on an individual with no tooth decay. (39)	○	○	○	○	○	○	○
Placing a picture of tooth decay on food packaging would be rejected by the public (40)	○	○	○	○	○	○	○

Placing a picture of tooth decay on food packaging would lead to feelings of guilt. (42)	○	○	○	○	○	○	○

Page Break

BACo14) To what extent is it true or untrue that you have the following beliefs:

NB: In this question: The term "sugar" excludes sugar naturally present in fruits and milk. The term "food" refers to any substance that you eat or drink.

	Vey true	True	Somewhat true	Neutral	Somewhat untrue	Untrue	Very untrue
Placing a picture of tooth decay on food packaging would help to reduce the need for dental treatments. (36)	○	○	○	○	○	○	○
Placing a picture of tooth decay on food packaging would be acceptable on a sugary drink. (62)	○	○	○	○	○	○	○

Placing a picture of tooth decay on food packaging would reduce sugar intake. (37)	○	○	○	○	○	○	○
Placing a picture of tooth decay on food packaging would be acceptable on sugary food. (38)	○	○	○	○	○	○	○

Page Break

End of Block: 6) Free Sugar Intake:

Start of Block: 7) Email Address:

EA.1 Please type **your email address** below (to receive the incentive):
This must be the same email address which you have communicated with the researcher.

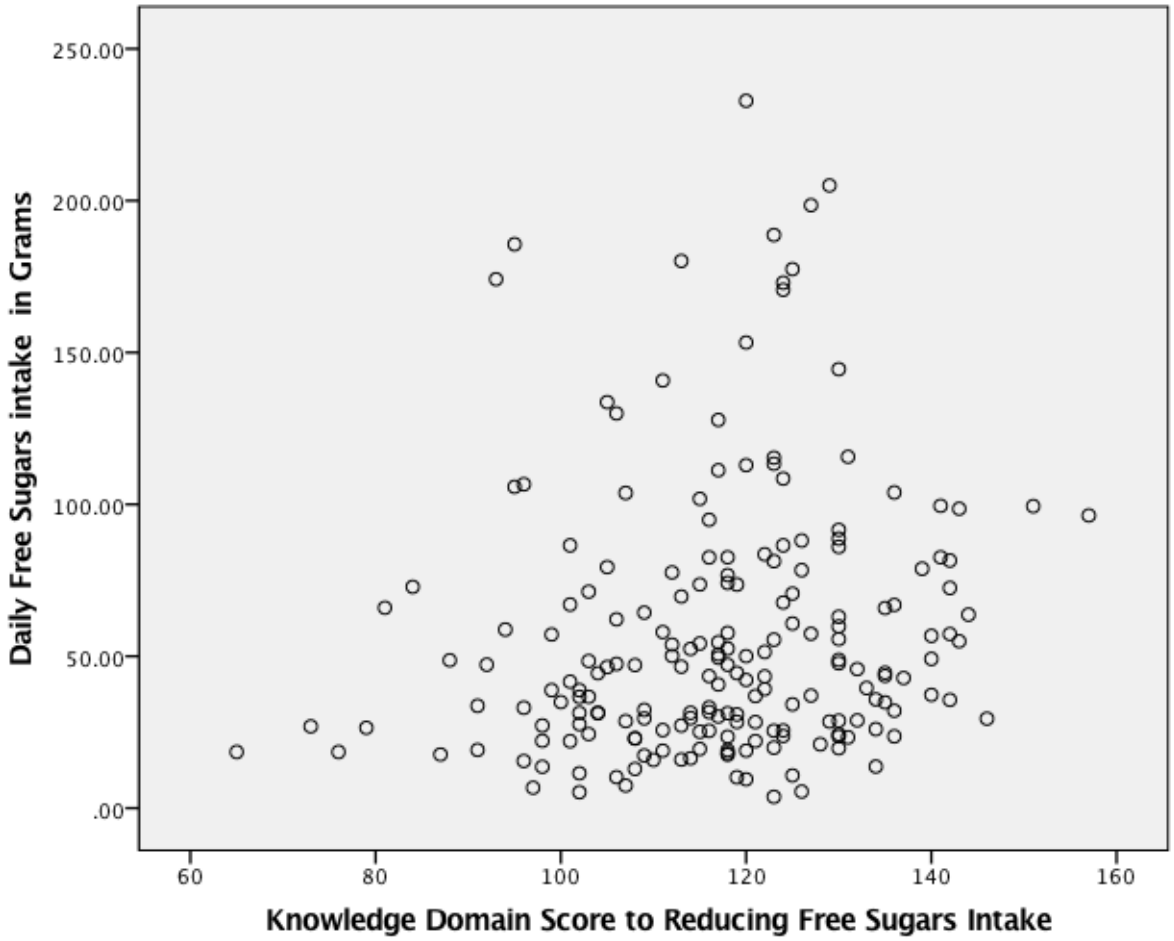
_____

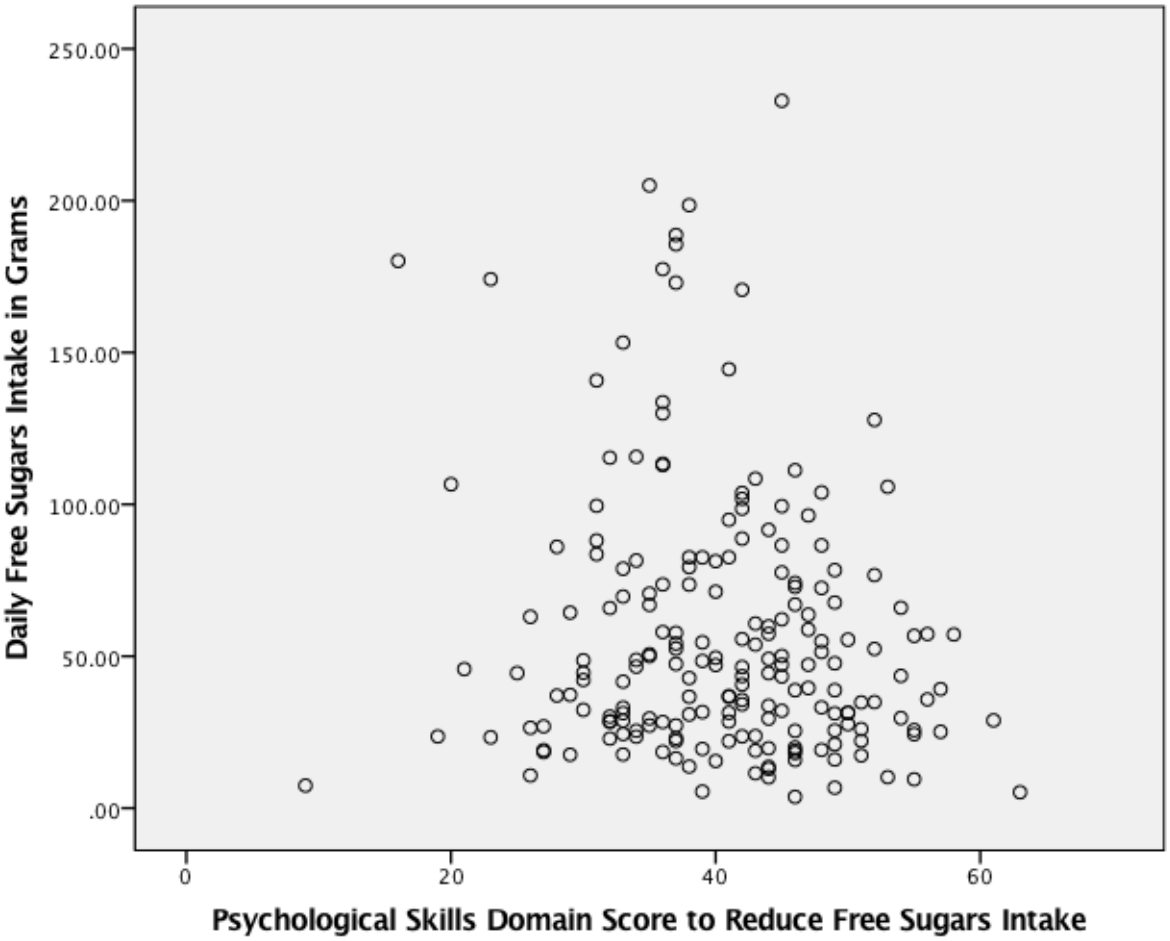
Page Break

EA.2 Thank so much for taking part in this survey.

End of Block: 7) Email Address:

13.9.7. Correlation between TDF and Free sugar intake

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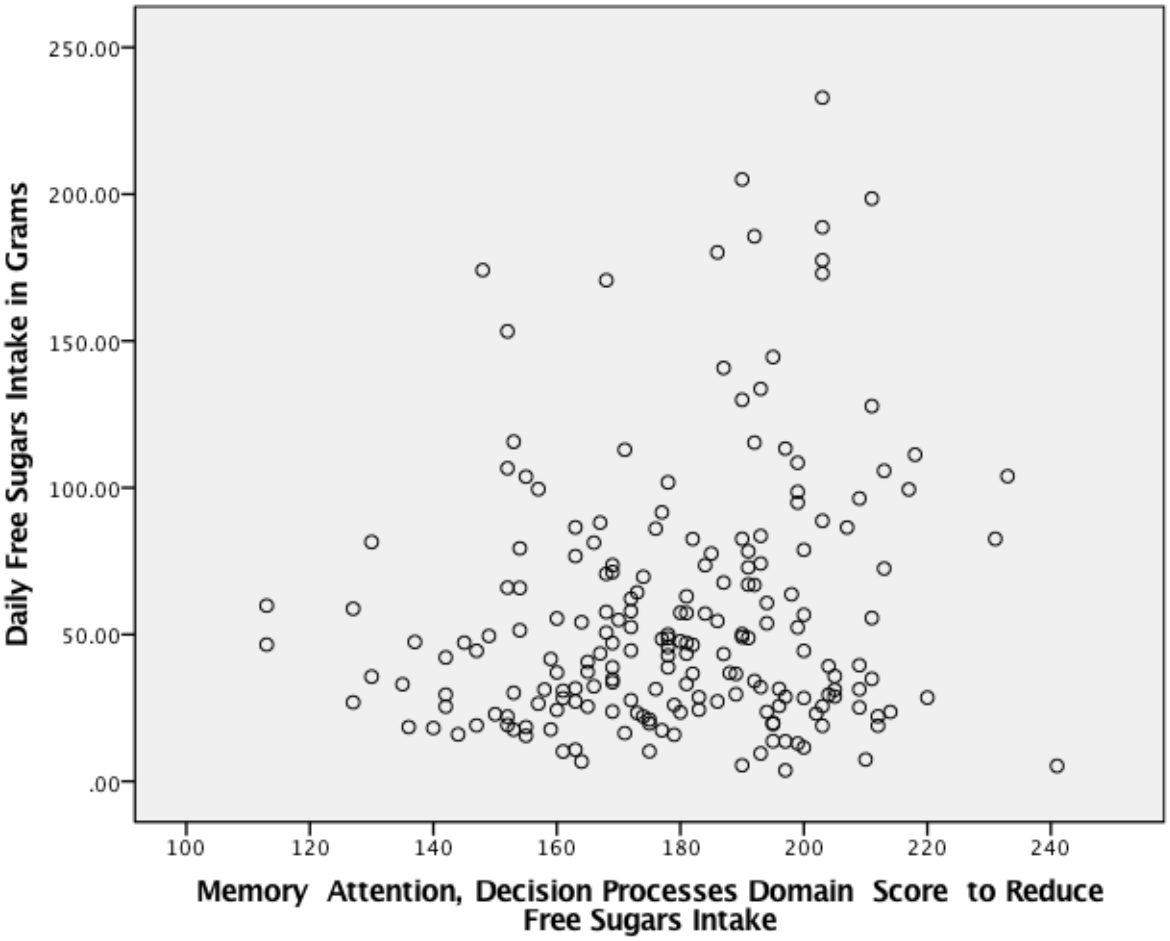
Psychological Skills Domain Score to Reduce Free Sugars Intake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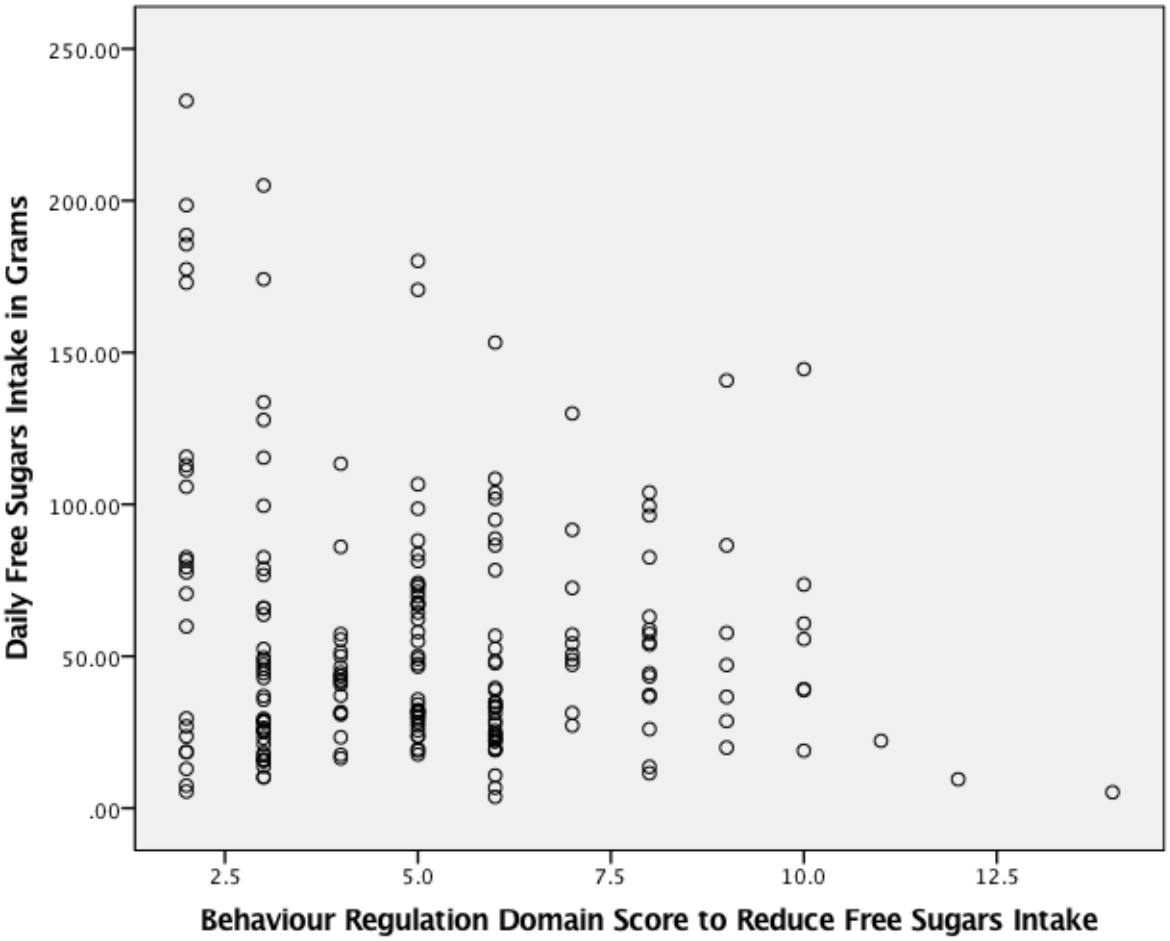
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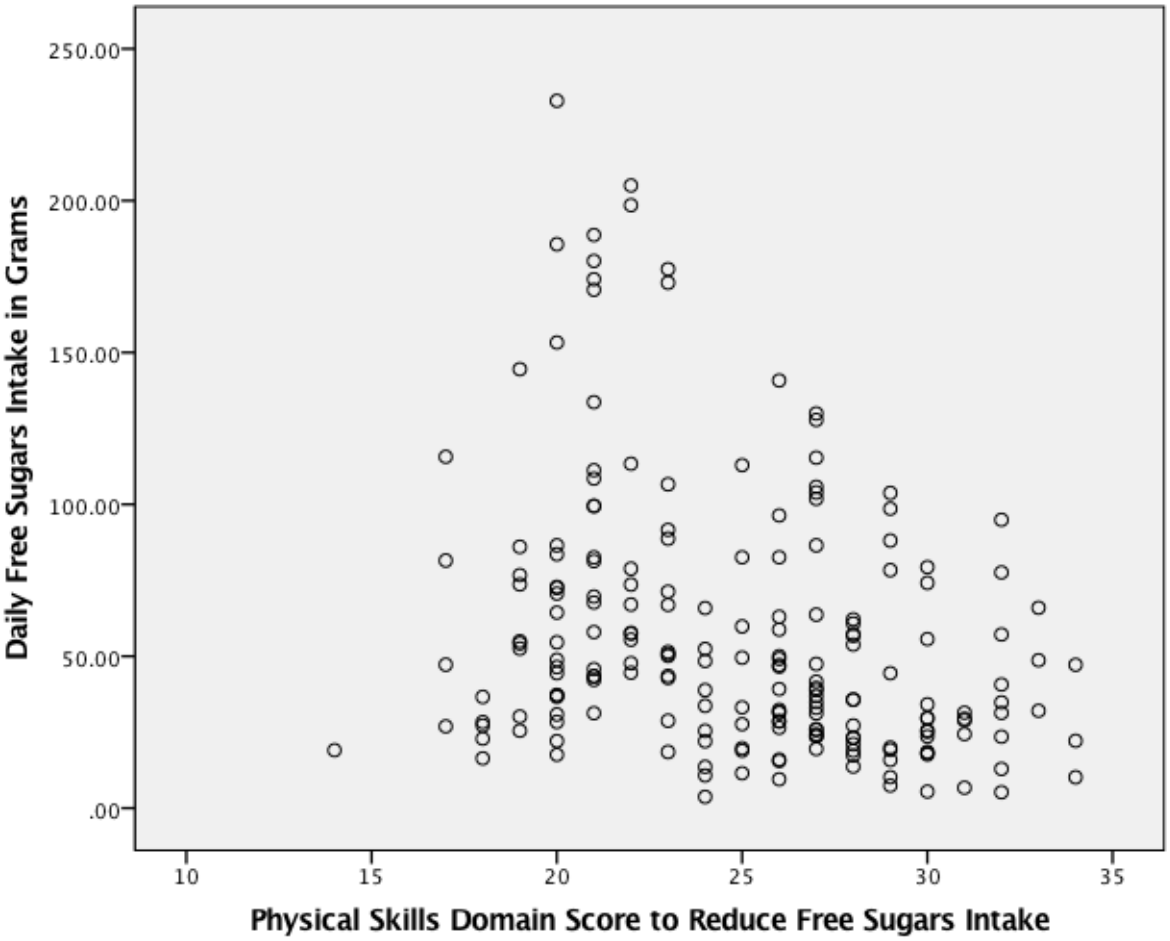
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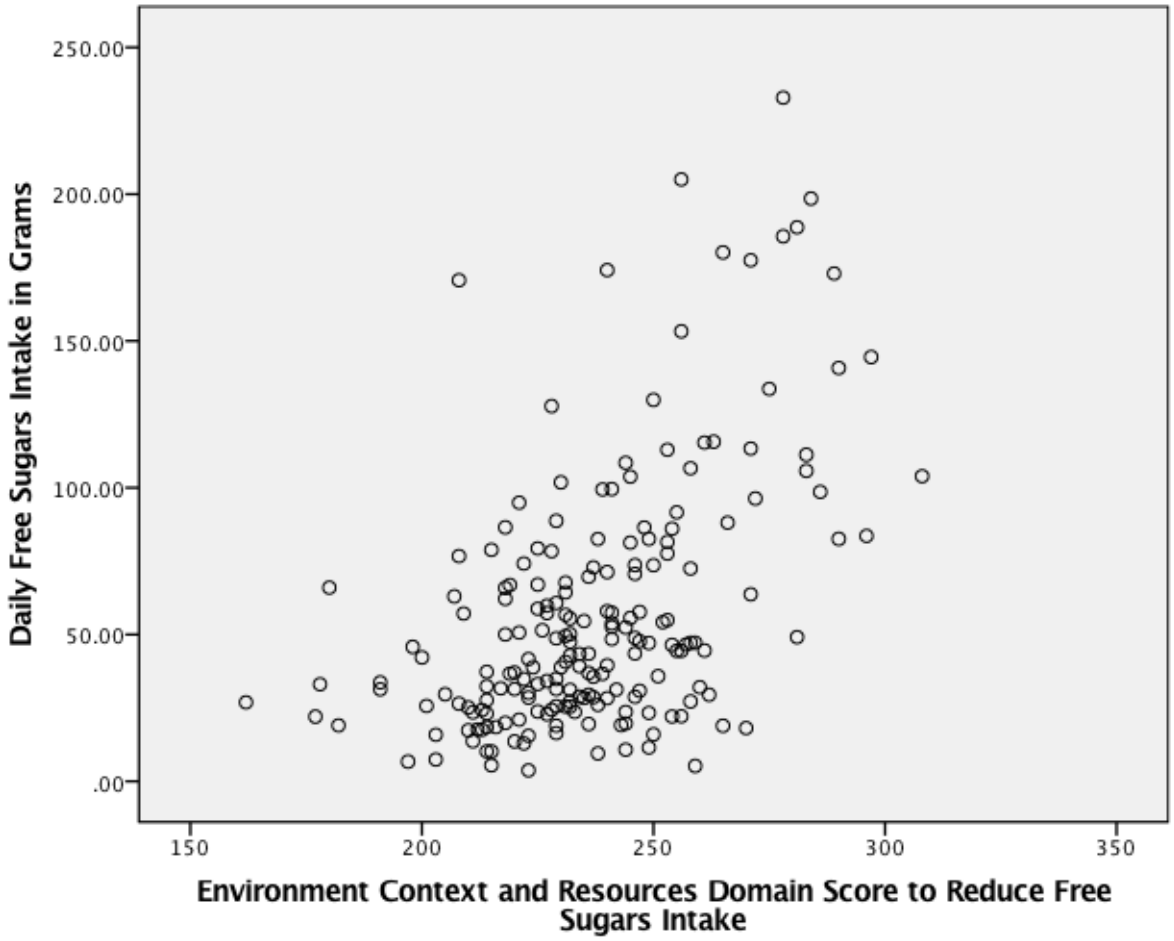
Physical Skills Domain Score to Reduce Free Sugars Intake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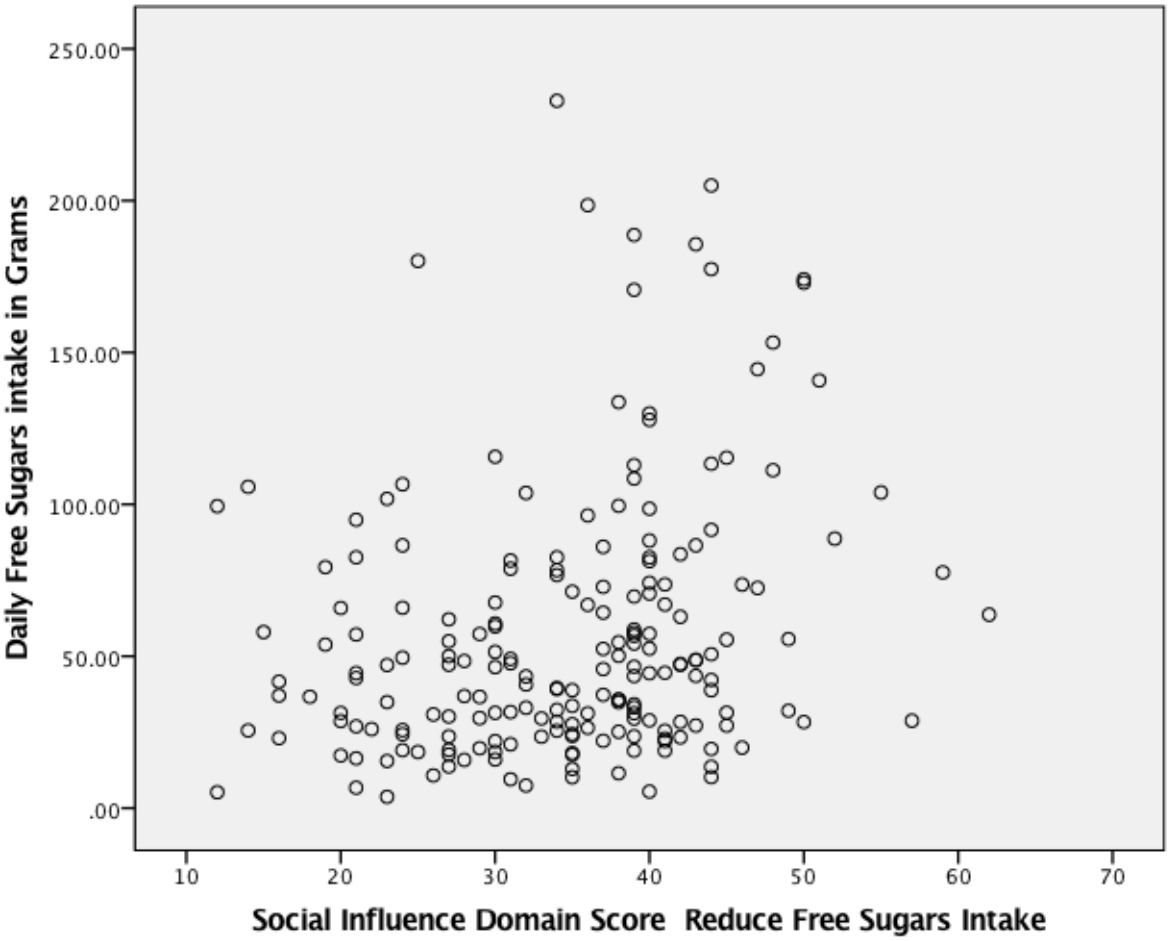
Environment Context and Resources Domain Score to Reduce Free Sugars Intake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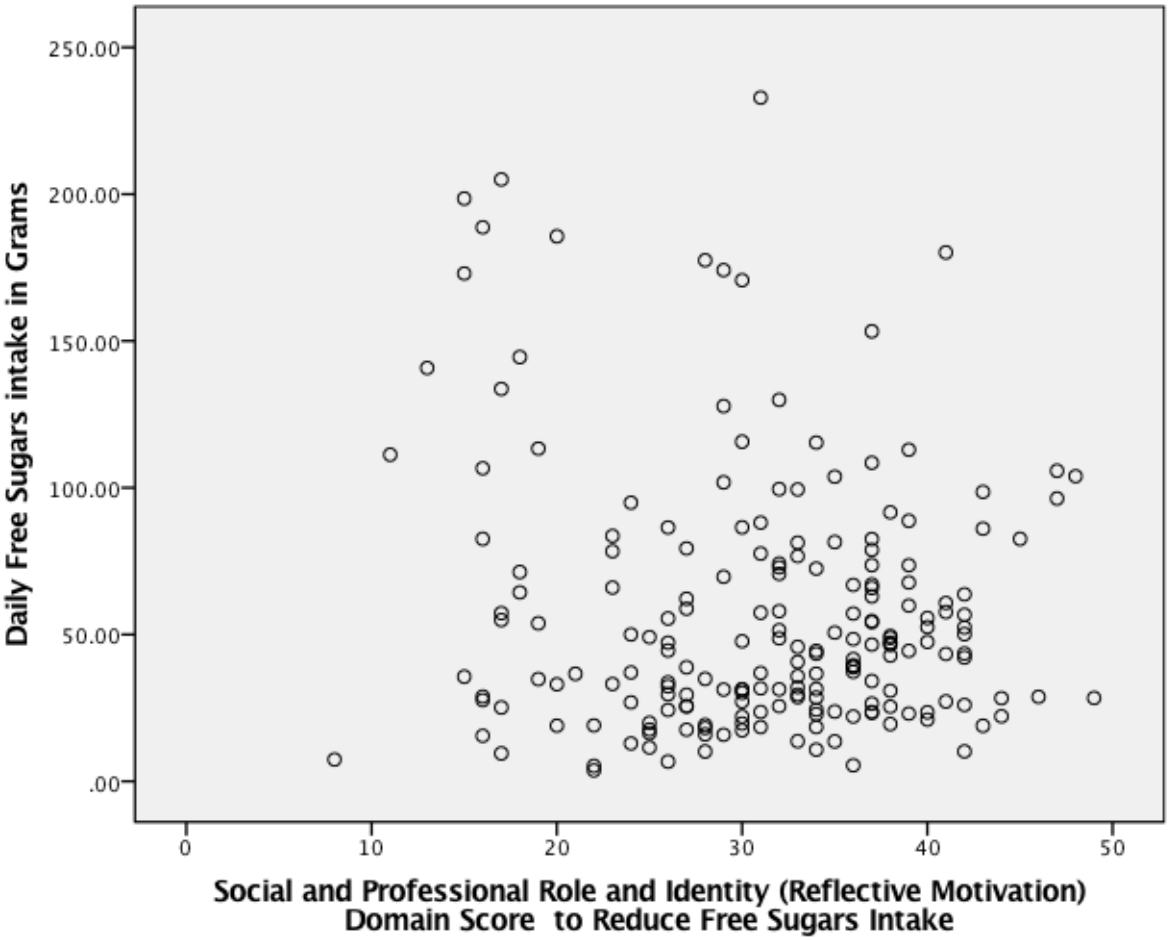
Social Influence Domain Score Reduce Free Sugars Intake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40
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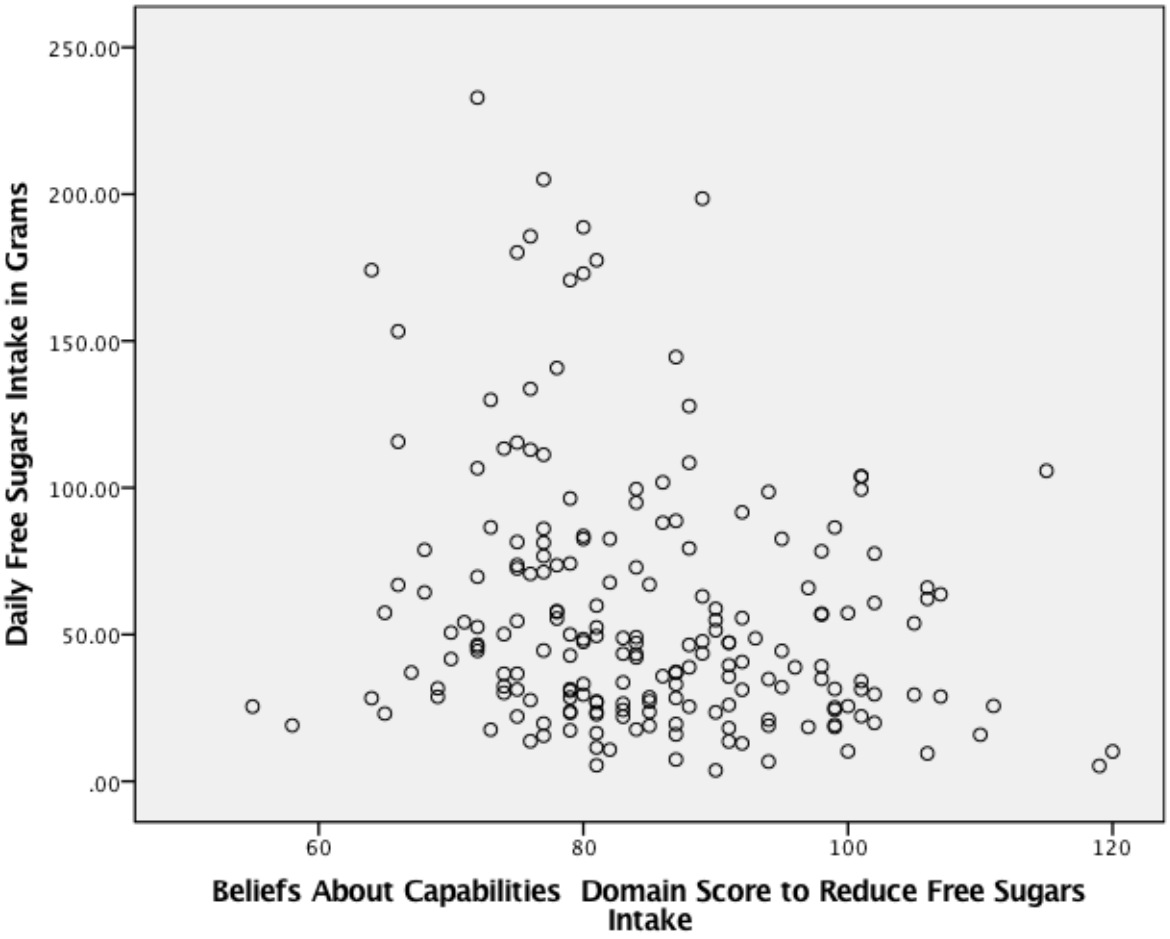
Social and Professional Role and Identity (Reflective Motivation) Domain Score to Reduce Free Sugars Intake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100
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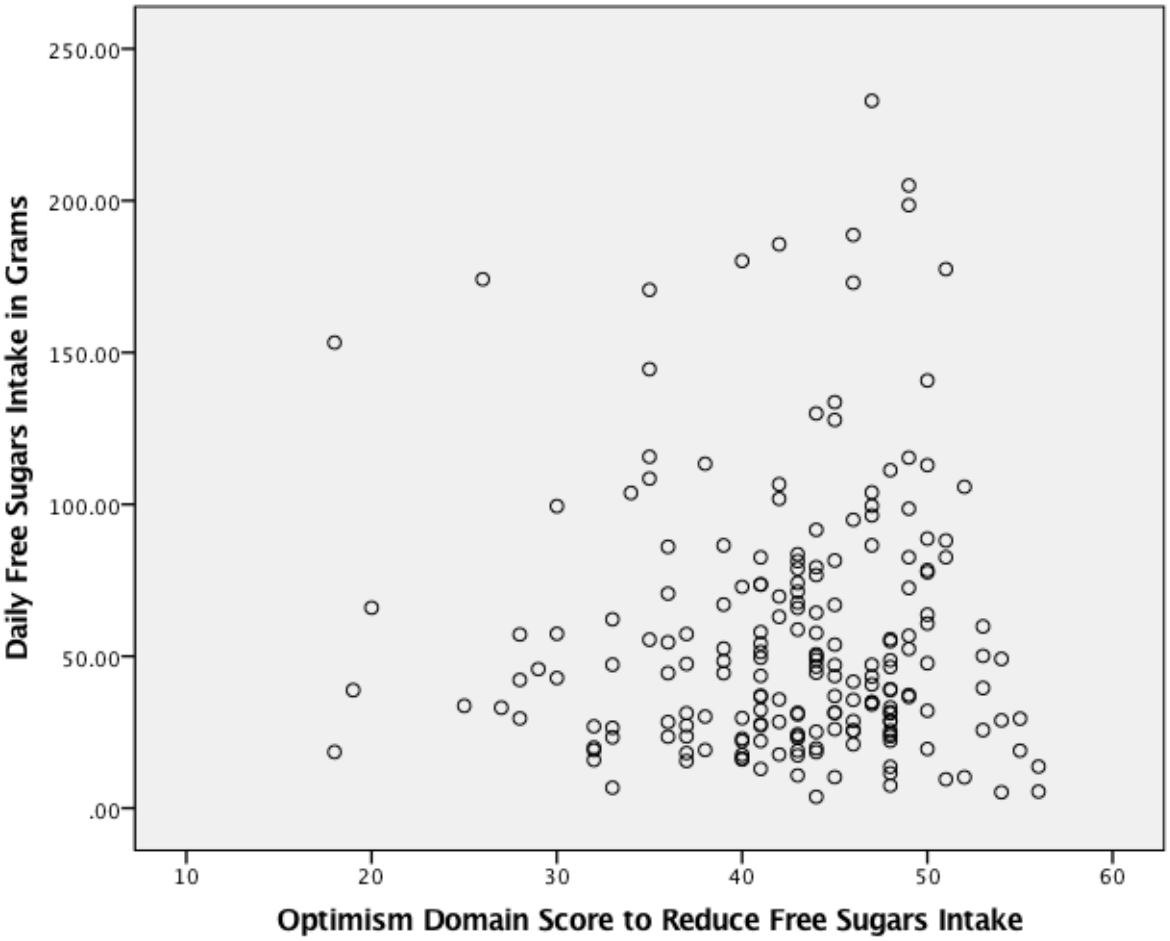
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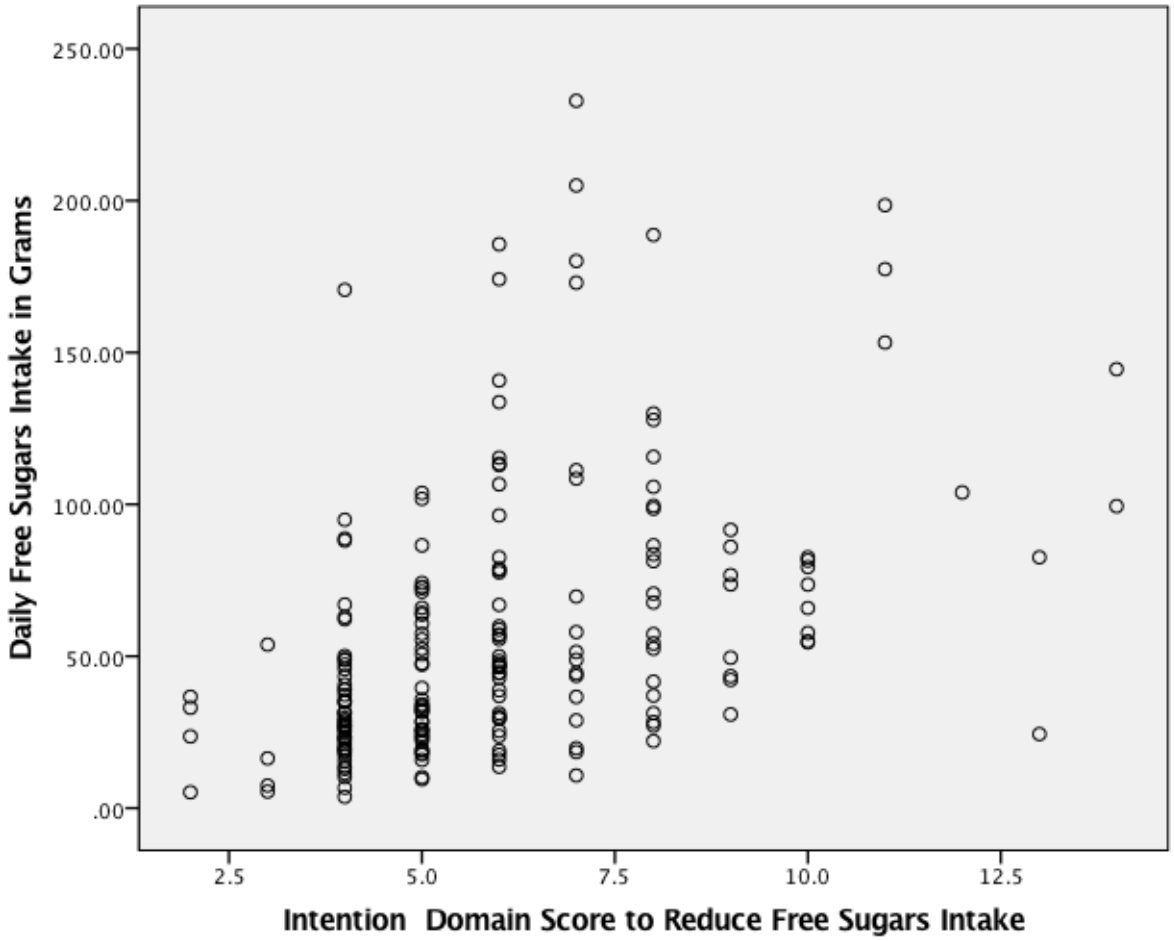
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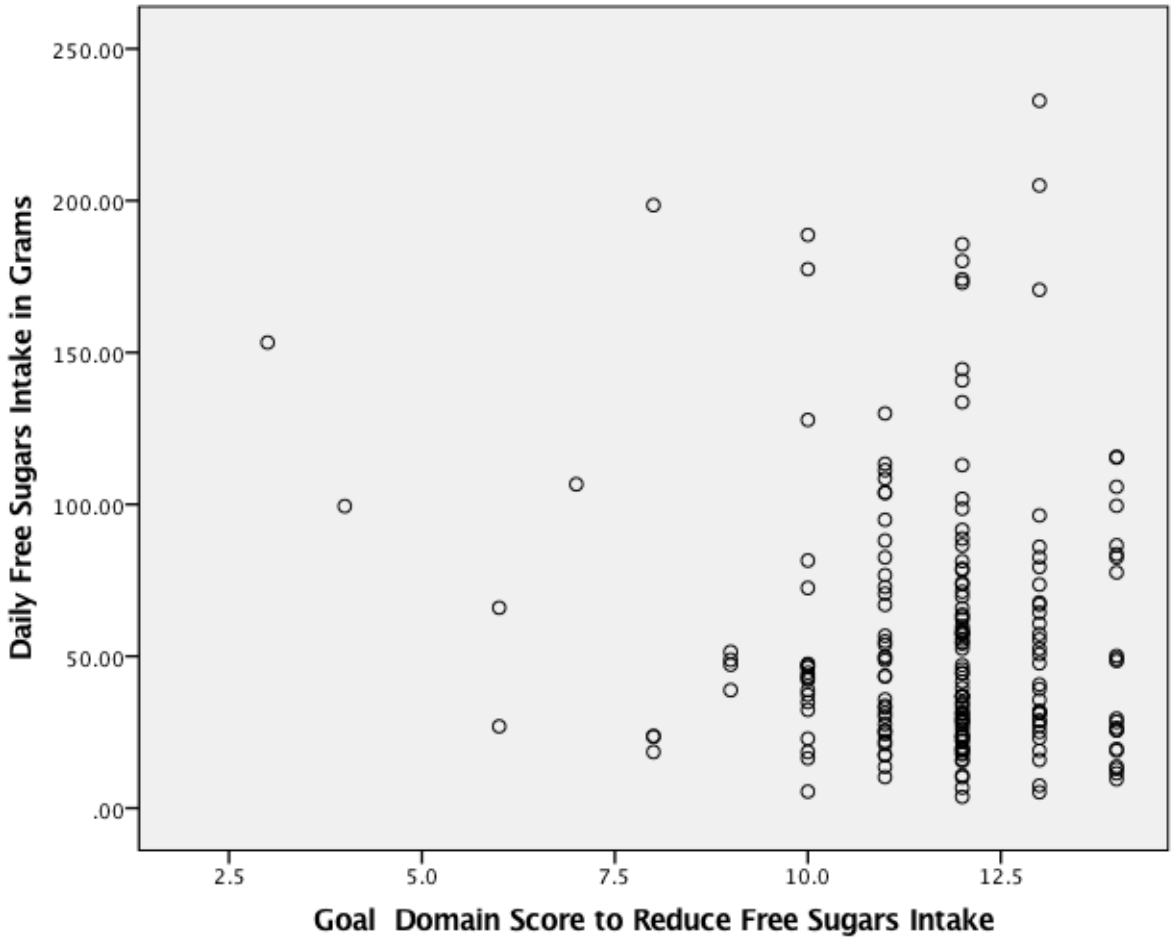
2.5
5.0
7.5
10.0
12.5
Intention Domain Score to Reduce Free Sugars Intake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10.0
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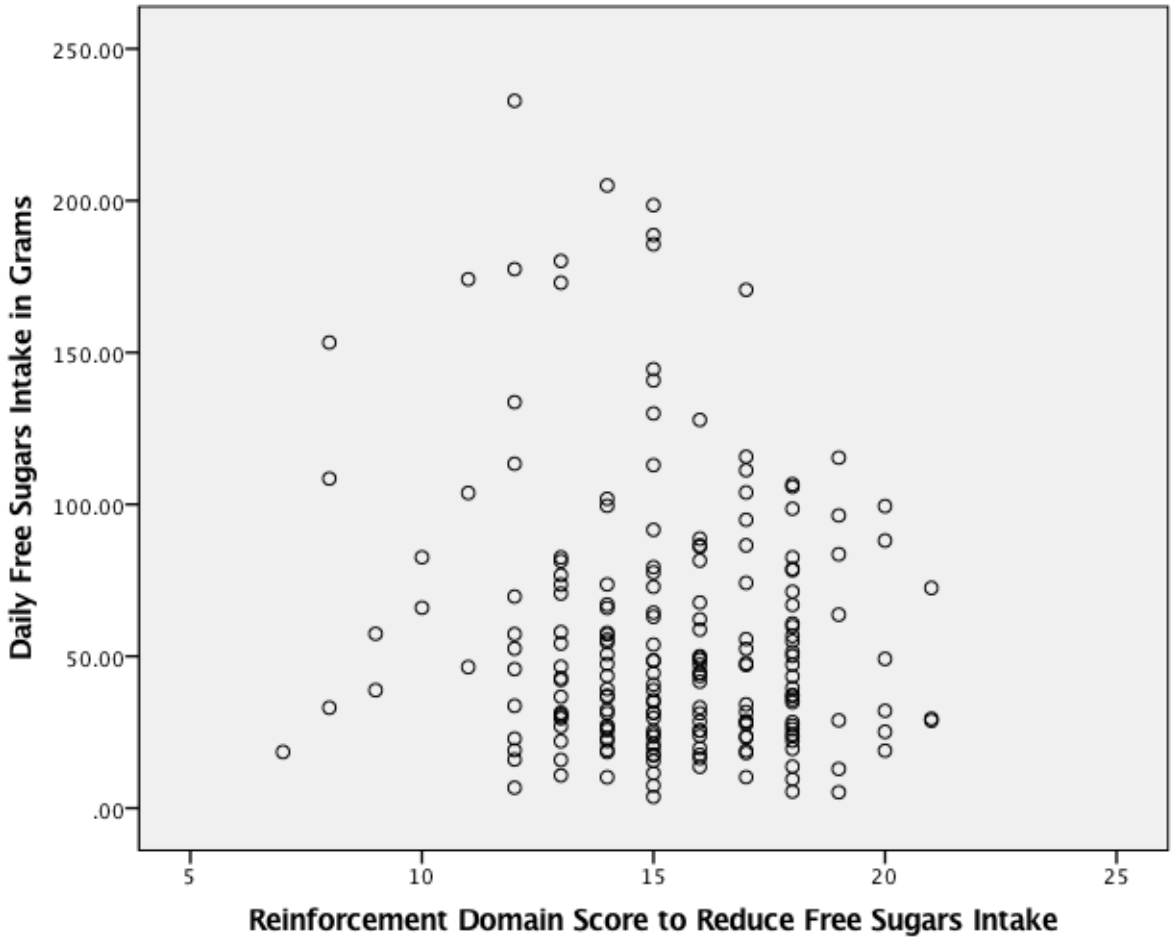
Goal Domain Score to Reduce Free Sugars Intake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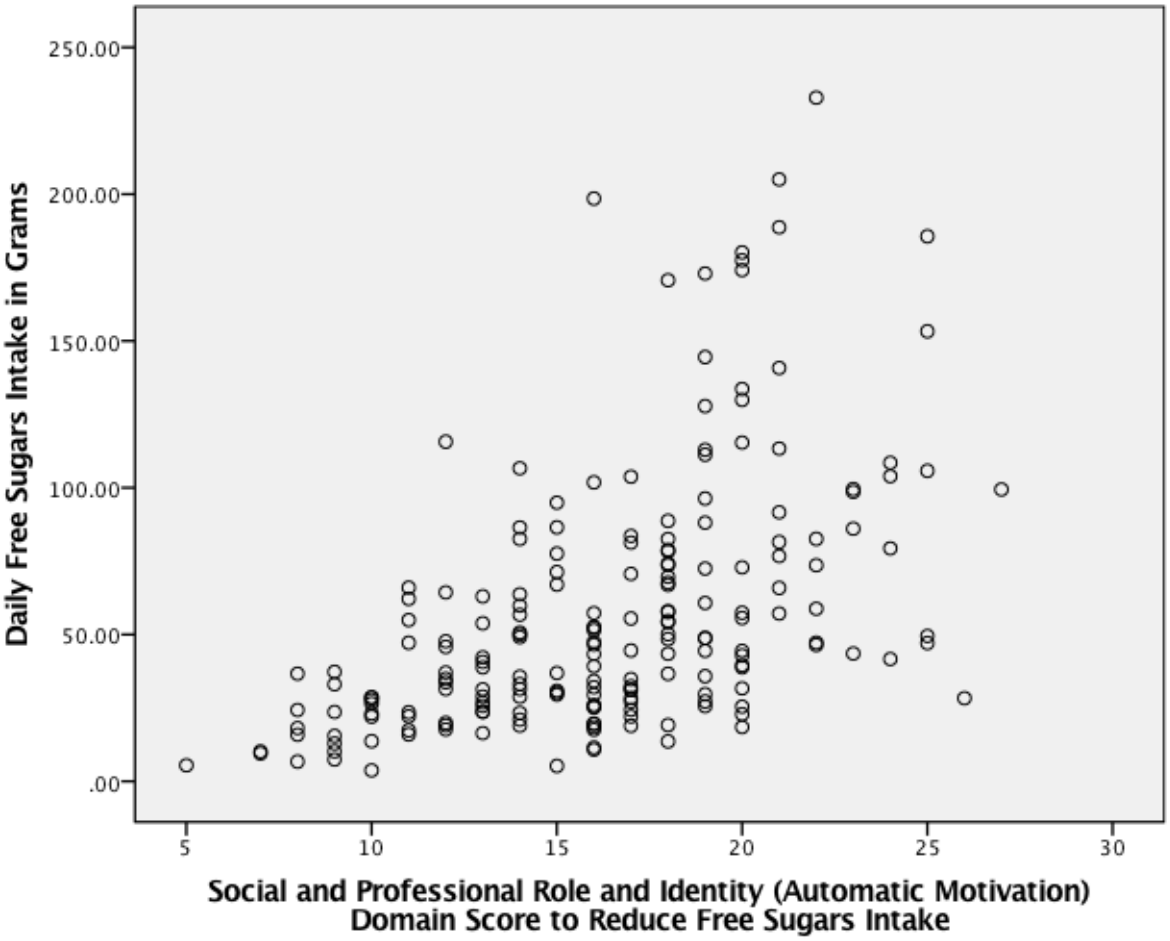
5
10
15
20
25
Reinforcement Domain Score to Reduce Free Sugars Intake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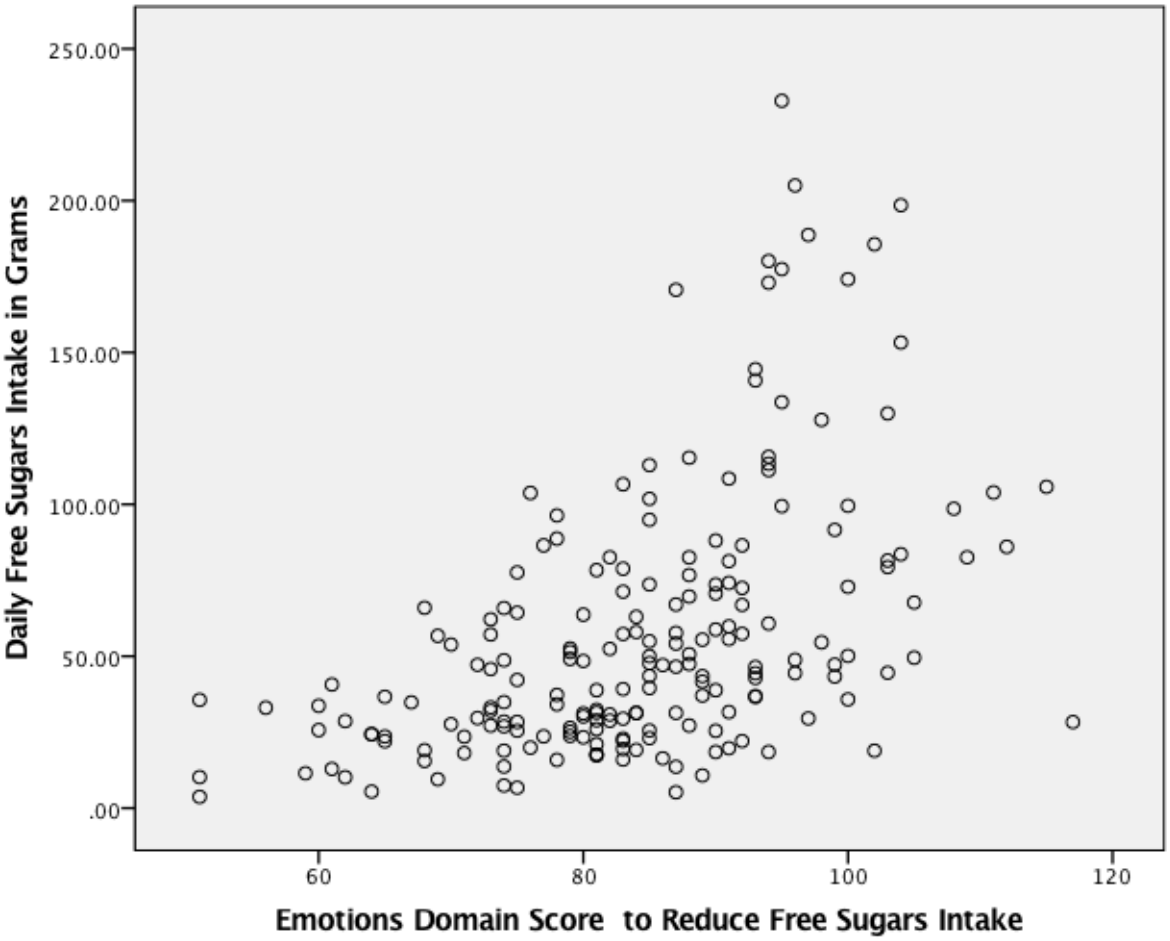
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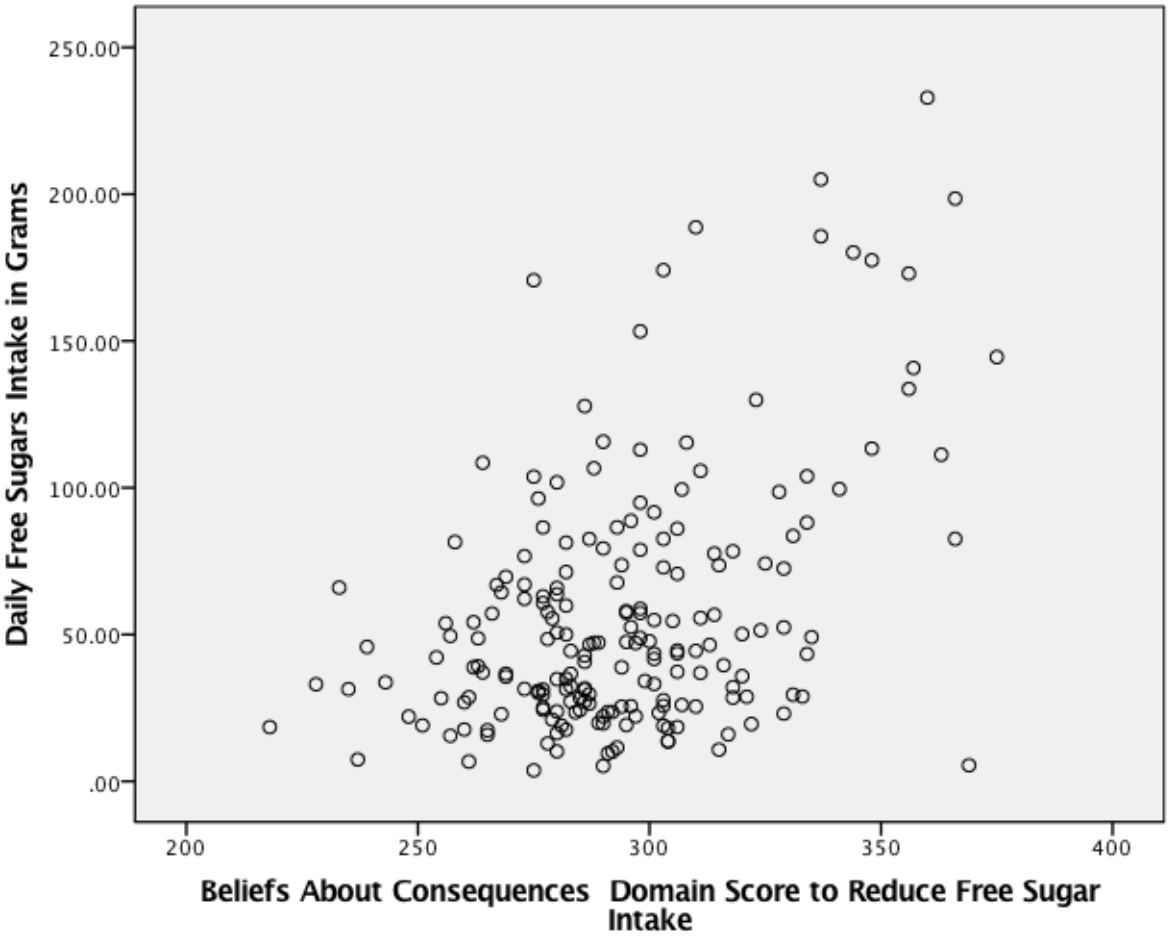
60
80
100
120
Emotions Domain Score to Reduce Free Sugars Intake


250.00
200.00
150.00
100.00
50.00
.00
Daily Free Sugars Intake in Grams
200
250
300
350
400
Beliefs About Consequences Domain Score to Reduce Free Sugar Intake