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DOI:

[10.1111/apa.17317](https://doi.org/10.1111/apa.17317)

Document Version

Publisher's PDF, also known as Version of record

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Citation for published version (APA):

Carter, B., Payne, M., Rees, P., Sohn, S. Y., Brown, J., & Kalk, N. J. (2024). A multi-school study in England, to assess problematic smartphone usage and anxiety and depression. *Acta Paediatrica, International Journal of Paediatrics*, 113(10), 2240-2248. <https://doi.org/10.1111/apa.17317>

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ORIGINAL ARTICLE

A multi-school study in England, to assess problematic smartphone usage and anxiety and depression

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Abstract

Aim: To assess the association between problematic smartphone usage and anxiety and depression in adolescents.

Methods: A cross-sectional study in five schools in the UK were included. The primary outcome was moderate anxiety (GAD-7 ≥ 10) symptoms and secondary outcomes were moderate depression symptoms (PHQ-9 ≥ 10) and insomnia. Problematic smartphone usage was assessed using screentime and the Smartphone Addiction Scale. A multi-level logistic regression was fitted and adjusted Odds Ratio (aOR) with 95% confidence intervals (95% CI) reported. A mediation analysis was conducted.

Results: Of the five included schools, 657 adolescents aged 16–18 years were enrolled. The median age was 17.5 years (17–18 [IQR]) and 508 (77.3%) were female. Of these 188 (28.6%) exhibited moderate anxiety and 226 (34.4%) moderate depression symptoms. Almost two thirds (421, 64.1%) have tried to cut down their smartphone use and 81 (12.5%) wanted help to reduce use. Problematic smartphone use was associated with increased anxiety (aOR = 2.03, 95% CI 1.28–3.23); depression (aOR = 2.96, 95% CI 1.80–4.86); and insomnia (aOR = 1.64, 95% CI 1.08–2.50). Screentime was not associated with anxiety ($\beta = 0.99$, 95% CI 0.91–1.08); or depression ($\beta = 0.98$, 95% CI 0.89–1.07). Problematic smartphone use had a significant direct, indirect and total effect on both anxiety and depression.

Conclusion: Problematic smartphone usage was associated with anxiety and depression, independent of screentime. Interventions are needed to reduce problematic use.

KEYWORDS

adolescents, anxiety, depression, problematic smartphone usage, screentime

Abbreviations: Apps, Smartphone applications; aMD, Adjusted mean difference; aOR, Adjusted odds ratio; GAD, Generalised Anxiety Disorder 7-item; IQR, Interquartile range; PHQ, The Patient Health Questionnaire adolescent-9-item; 95% CI, 95% Confidence Interval.

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1 | INTRODUCTION

Children and young people aged up to 25 are amongst the heaviest users of smartphones. Most adolescents own a smartphone and 24% resultantly report being constantly connected to the internet, an immersive online world of social media, gaming and video streaming.¹ Many adolescents have social media portfolios including multiple platforms and they commonly 'media multi-task' by engaging in more than one form of media concurrently.¹

Smartphones have many benefits to mental health and well-being such as improving social inclusion, encouraging community engagement, providing access to support networks and exposing users to new knowledge and ideas.² However, as smartphone usage in childhood and adolescence has grown to ubiquity,³ there has been a parallel increase in affective and anxiety disorders in this same population,⁴ which has further escalated during the COVID-19 pandemic.⁵ This has resulted in growing concerns of a link between smartphone usage and depression and anxiety. However, when the relationship between daily screen time and mental health outcomes has been examined in large adolescent general population samples, the association was negligible.⁶ One possible explanation for this is that the majority of adolescents' interact with technology in a non-harmful manner with a minority engaging with smartphones in a maladaptive manner associated with harm.

Globally between 10% and 30% of adolescents report 'addiction-like' interactions with their smartphone which has been termed problematic smartphone usage. Problematic smartphone usage includes loss of control of the amount of time spent using the smartphone, feelings of distress when denied access to a smartphone, continued use despite negative consequences and requiring increasingly long periods of use for satisfaction.⁷ Problematic smartphone usage is known to be associated with insomnia,⁸ but less is known about the potential mental health consequences such as risk of depression, anxiety,^{7,9,10} or suicidal ideation; in addition to risks of functional impairments such as poor school performance.^{11,12} Given the association between problematic smartphone use and insomnia, debate remains over the extent of any mediation between insomnia, anxiety and problematic smartphone use.

Whilst problematic smartphone use is an overarching term, the resultant adverse health outcomes are likely caused not by the device itself, but through using the smartphones' applications (herein called Apps). Adolescents' usage is dominated by social media platforms which include Instagram, Snapchat and WhatsApp which may be the cause of anxiety and depression.^{13,14} This effect may also be more pronounced in those with pre-existing compulsive behaviour disorders such as gambling or eating disorders.^{15,16}

The primary pre-specified hypothesis was to assess if there was any increased risk of probable anxiety in those participants with problematic smartphone usage, compared to those without. The primary objective of this study was to assess the association between anxiety and problematic smartphone use accounting for the mediating effect of insomnia.

Key notes

- This is one of the first European studies in adolescents to evaluate problematic smartphone usage and mental health outcomes.
- Problematic smartphone use was linked to poorer mental health. Adolescents with Problematic use used both Instagram and TikTok for longer daily, compared to those without. One in eight (12.5%) adolescents reported wanting help to cut down their use, and wanting help to cut down was 5 time greater in those with problematic use compared to those without.
- We found that adolescents acknowledge the harm associated with problematic smartphone use and some wanted help. Evidence-based interventions are needed to help adolescents with problematic use.

2 | METHODS

2.1 | Study design

A cross-sectional study was carried out across three regions of the UK (London, East-Midlands and South-West England). We included adolescents from five schools from January 31st to March 9th, 2020. Ethical approval was received from the King's College Research Ethics Office (Study ID: 9138; MRS-18/19-9138). Schools were approved and the Head Teacher, Head of the Sixth form, or Well-being lead were required to consent to the study taking place and to arrange a date and room for enrolment. Participants were informed of the study before hand and reminded during assembly on the day of enrolment. Enrolment was by convenience sampling.

Inclusion criteria: participants aged 16-18 years of age. Researchers attended a school assembly, then based in a classroom where students were invited to read the information sheet, consent form and complete the case report form.

The study questionnaire was developed in conjunction with young adults to determine the ease and understanding of the questions and instruments by similar aged group and has previously been piloted on a large young adult population.¹⁰ The questionnaire consisted of a balance of positive and negative questions about smartphone technology, as well as participant demographics, smartphone usage and widely used validated instruments on anxiety symptoms, depression symptoms and insomnia.

2.1.1 | Outcomes

The primary outcome was self-reported anxiety using the Generalised Anxiety Disorder 7-item version (GAD).¹⁷ Scores range between 0 to 21 and a score of 10 or higher is considered to represent moderate

anxiety symptoms (herein described as anxiety). The secondary outcome was the presence of symptoms of depression using the Patient Health Questionnaire-adolescent 9-item version (PHQ) to measure moderate depressive symptoms (defined by ≥ 10).¹⁸

2.1.2 | Exposure measures

The primary exposure problematic smartphone usage was defined using scores from the Smartphone Addiction Scale – Short Version.¹⁹ This is a 10-item validated instrument to assess problematic smartphone usage in adolescents. It is the most commonly used validated tool and has been used by 83 studies on 33831 participants across more than 24 countries.⁴ Scores range from 10 to 60 and scores of 31 and 33 are the thresholds used for males and females respectively to indicate problematic smartphone use. Daily screentime was reported as a secondary assessment, using the previous day as an objective measure via the device screentime App.

The Insomnia Severity Index 7-item version was developed on an adult population and used to measure insomnia. Scores range from 0 to 27 and a score of 15 or higher is used to define insomnia.²⁰ Insomnia was assessed as an outcome, but also to control for the role of insomnia when assessing the association between anxiety, depression and problematic smartphone use.

2.1.3 | Smartphone App use

App use was captured from the following Apps: Instagram; Snapchat; TikTok; YouTube; WhatsApp/Messenger; YouTube/Netflix; Gaming; Internet; and Facebook. Facebook was included as a control as it is not typically used by adolescents.

2.1.4 | Smartphone usage patterns

We additionally asked the participants about their usage behaviour, for example, where they kept their smartphone at night and at meal-times, what their latest time of use was, whether they wished to reduce their usage and what strategies they had tried.

2.2 | Sample size justification

In a recent systematic review, it was estimated that 26% of participants with problematic smartphone use reported increased anxiety but only 10% of those not exhibiting problematic smartphone usage reported anxiety.⁷ In order to detect the difference in the proportion of adolescents with anxiety with problematic smartphone usage (25%), compared to those without problematic smartphone usage (15%) using a chi-squared with 80% power and 5% significance, we needed to include 500 participants. To account for 15% missing data, we will enrol 600 participants.

2.3 | Data analysis

Demographic and smartphone usage characteristics were summarised, comparing adolescents with moderate anxiety to those without, as well as those with problematic smartphone use compared to those without.

2.4 | Statistical analyses

All outcomes were binary and analysed using a multi-level logistic mixed-effects models, fitting school as a random intercept to account for the structure of the data, with clustering occurring within schools. The fixed effects parameters included: age; sex; ethnicity; screentime and problematic smartphone use. Analyses were reported with crude odds ratios (OR) and multi-variable adjusted OR (aOR), alongside 95% confidence intervals (95% CI) and *p*-values using Stata v17.

2.4.1 | Smartphone app usage

The daily length of App usage (in hours per day) was fitted as a multi-level regression, adjusted for the same fixed effects as the primary outcome to assess the adjusted mean difference (aMD) between the length of App use for those with problematic smartphone use and those without.

2.4.2 | Mediation analysis

The mediation analysis was performed using parametric regression, to estimate models of the mediator and the outcome, both of which were binary. The mediator (insomnia) was regressed on problematic smartphone use and covariates (school year, gender, ethnicity and hours per day on social media). The outcomes (anxiety/depression) were each regressed on problematic smartphone use, covariates and the mediator. The natural indirect effect, natural direct and total effect were bootstrapped with 500 replications to derive bias corrected 95% confidence intervals and valid standard errors. This was performed using the parmed packages in Stata version 17.²¹

2.4.3 | Missing data and population under investigation

Individuals with missing item data in no more than 30% of the instruments GAD, PHQ, Insomnia Severity Index and Smartphone Addiction Scale, had the missing item data pro-rata mean imputed.²² Due to the completeness of the data collected, a complete case analysis was used.

TABLE 1 Characteristics of the Included Children, by problematic smartphone use assessed using the Smartphone Addiction Scale–Short form.

	Problematic smartphone usage			
	Problematic usage (N = 123)	None (N = 527)	Missing (N = 7)	Total (N = 657)
School				
A	16 (17.2)	75 (80.6)	2 (2.2)	93 (14.2)
B	23 (14.0)	142 (85.4)	1 (0.6)	166 (25.3)
C	53 (20.6)	201 (78.2)	3 (1.2)	257 (39.1)
D	15 (15.8)	79 (83.2)	1 (1.0)	95 (14.5)
E	16 (34.8)	30 (65.2)	0 (0.0)	46 (7.0)
School year				
Year 12	58 (17.6)	270 (81.8)	2 (0.6)	330 (50.2)
Year 13	65 (19.9)	257 (78.6)	5 (1.5)	327 (49.8)
Age, median (Q1, Q3)	17.5 (17.1, 18.0)	17.5 (17.0, 18.0)	17.5 (17.0, 18.0)	17.5 (17.0, 18.0)
Gender				
Male	25 (17.7)	115 (81.6)	1 (0.7)	141 (21.5)
Female	97 (19.1)	405 (79.7)	6 (1.2)	508 (77.3)
Other	1 (20.0)	4 (80.0)	0 (0.0)	5 (0.8)
Missing	0 (0.0)	3 (100.0)	0 (0.0)	3 (0.5)
Ethnicity				
White	84 (18.6)	364 (80.5)	4 (0.9)	452 (68.8)
Black	11 (23.9)	35 (76.1)	0 (0.0)	46 (7.0)
Asian	17 (18.1)	74 (78.7)	3 (3.2)	94 (14.3)
Mixed	9 (18.8)	39 (81.2)	0 (0.0)	48 (7.3)
Other	2 (11.8)	15 (88.2)	0 (0.0)	17 (2.6)
Daily length of time on a smartphone Median (Q1, Q3)	5 (4.0, 6.5)	4 (3.0, 5.0)	5 (2.4, 6.0)	4 (3.0, 6.0)
Anxiety				
No/mild	69 (15.3)	380 (84.4)	1 (0.2)	450 (68.5)
Moderate/severe	53 (28.2)	134 (71.3)	1 (0.5)	188 (28.6)
Missing	1 (5.3)	13 (68.4)	5 (26.3)	19 (2.9)

3 | RESULTS

The included five schools were from three regions of the UK (two from greater London, two from East Midlands and one from Southwest England), two were private schools, two were academies and one a higher education college. The median index of multiple deprivation for the schools were 7 (range 2–10).

From the five schools 657 participants were recruited, with a median age of 17.5 (17.0, 18.0 [IQR]). All were aged between 16 to 18 years old (see Table 1). Of these 508 (77.3%) were female and 452 were white (68.8%), 94 (14.3%) Asian, 48 mixed (7.3%) and 46 (7.0%) were black. The median midweek daily screen time was 4 h (3, 6 [IQR]).

Of the adolescents, 188 (28.6%) reported moderate anxiety and ranged between 15.7% to 37.0% across the five schools (Table S1). Of the 450 without moderate anxiety, 69 (15.3%) were found with problematic smartphone usage and of the 188 with moderate anxiety, 53 (28.2%) had problematic smartphone usage (Table 1). Moderate depression was found in 34.4% of the adolescents and

insomnia in 34.1%. Problematic smartphone use was reported by 123 (18.7%) adolescents and this ranged between 13.0% to 43.1% across the five schools.

3.1 | Smartphone usage patterns

The majority of the adolescents kept their smartphone in their bedroom at night ($n = 563$, 85.7%) and 315 (47.9%) kept their smartphone with them during mealtimes with 117 (17.8%) kept their notifications on (Table S2). Of the adolescents, 228 (24.7%) reported that their smartphones often impacted on their school homework and revision and 378 (57.6%) reported that their smartphone impacted on their school performance. Almost two thirds reported (421, 64.1%) to have tried to cut down their use and 81 (12.5%) reported wanting help cutting down their use. Those with problematic use exhibited five times the odds of wanting help to cut down compared to those that did not have (OR = 5.02, 95%CI 3.07–8.23).

TABLE 2 Association between demographics, problematic smartphone usage and moderate anxiety (GAD) symptoms, using a crude and multi-variable mixed-effects logistic regression analyses presenting the crude odds ratio (OR) and adjusted OR (aOR) with 95% confidence intervals (95% CI).

	Anxiety (GAD ≥10)			
	Odds ratio (OR) (95% CI)	p-Value	Adjusted ^a OR (aOR) ^b (95% CI)	p-Value
Gender				
Male	Reference		Reference	
Female	2.33 (1.45–3.76)	0.001***	1.99 (1.18–3.34)	0.010*
School year				
Year 12	Reference		Reference	
Year 13	1.47 (1.03–2.07)	0.031*	1.24 (0.84–1.84)	0.276
Ethnicity				
White	Reference		Reference	
Black	0.59 (0.29–1.22)	0.15	0.45 (0.20–1.03)	0.060
Asian	0.62 (0.36–1.07)	0.09	0.49 (0.27–0.92)	0.025*
Mixed	0.69 (0.33–1.46)	0.33	0.64 (0.28–1.50)	0.308
Other	1.30 (0.46–3.68)	0.62	1.07 (0.32–3.61)	0.916
Insomnia				
None	Reference		Reference	
Sub-threshold	1.75 (0.96–3.20)	0.067	2.14 (1.10–4.15)	0.025*
Moderate insomnia	5.35 (2.90–9.88)	<0.001***	6.42 (3.24–12.70)	<0.001***
Severe	13.97 (5.82–33.51)	<0.001***	15.67 (5.91–41.51)	<0.001***
Problematic smartphone use				
No	Reference		Reference	
Yes	2.14 (1.41–3.24)	<0.001***	2.03 (1.28–3.23)	0.003**
Screentime				
	1.07 (0.99–1.15)	0.080	0.96 (0.87–1.05)	0.37

^aMulti-variable analysis adjusted for: sex; school year, ethnicity, hours on phone and Problematic smartphone use.

^bThe analysis included 614 observations (94.0% completion), 19 Observations were missing GAD and a further 24 missing covariate data.

*Indicates statistical significance at $p < 0.05$. **Indicates statistical significance at $p < 0.01$.

***Indicates statistical significance at $p < 0.001$.

3.2 | Statistical analyses

In the primary multi-level adjusted analysis, problematic smartphone usage was associated with anxiety adjusted OR (aOR) = 2.03 (95% CI 1.28–3.23; $p = 0.003$; Table 2). In addition, gender was associated with anxiety (female aOR = 1.99; 95% CI 1.18–3.34; $p = 0.01$). Neither school year, ethnicity or daily duration of smartphone use was associated with anxiety. In the secondary analyses, there was an association between problematic smartphone usage and depression (aOR = 2.96; 95% CI 1.80–4.86; $p < 0.0001$; Table 3); and insomnia aOR = 1.64 (95% CI 1.08–2.50; $p = 0.02$).

Screentime was only associated with insomnia ($\beta = 1.15$, 95% CI 1.06–1.24, $p < 0.001$) and was not associated with anxiety ($\beta = 0.99$, 95% CI 0.91–1.08, $p = 0.82$) or depression ($\beta = 0.98$, 95% CI 0.89–1.07, $p = 0.63$, Table 3).

3.3 | Smartphone app usage

There was an association between problematic smartphone usage and increased usage of some Apps. On average problematic smartphone users spent an additional 29 min on Instagram per day (95% CI

	Depression (PHQ ≥10)			
	Odds ratio (OR) (95% CI)	p-Value	Adjusted ^a OR (aOR) ^b (95% CI)	p-Value
Gender				
Male	Reference		Reference	
Female	2.46 (1.57–3.88)	<0.0001***	2.48 (1.44–4.28)	0.001**
School year				
Year 12	Reference		Reference	
Year 13	1.51 (1.08–2.10)	0.017*	1.17 (0.77–1.76)	0.463
Ethnicity				
White	Reference		Reference	
Black	0.95 (0.50–1.81)	0.875	0.68 (0.29–1.55)	0.356
Asian	1.03 (0.63–1.70)	0.895	0.70 (0.38–1.31)	0.268
Mixed	0.70 (0.34–1.46)	0.344	0.63 (0.26–1.54)	0.308
Other	1.71 (0.62–4.76)	0.300	2.36 (0.62–8.95)	0.209
Insomnia				
None			Reference	
Sub-threshold	5.03 (2.34–10.80)	<0.001***	6.87 (2.85–16.61)	<0.001***
Moderate insomnia	22.32 (10.10–49.36)	<0.001***	31.02 (12.29–78.28)	<0.001***
Severe	142.53 (39.6–513.6)	<0.001***	185.01 (44.97–761.09)	<0.001***
Problematic usage				
No	Reference		Reference	
Yes	2.91 (1.93–4.40)	<0.0001***	2.96 (1.80–4.86)	<0.0001***
Screentime (h)				
	1.11 (1.03–1.20)	0.007**	0.98 (0.89–1.07)	0.629

^aMulti-variable analysis adjusted for: sex; school year, ethnicity, hours on phone and problematic smartphone use.

^bThe analysis included 616 observations (93.8% completion), 17 Observations were missing PHQ and a further 24 missing covariate data.

*Indicates statistical significance at $p < 0.05$. **Indicates statistical significance at $p < 0.01$.

***Indicates statistical significance at $p < 0.001$.

15.0–43.8; $p = 0.005$), or 22min on TikTok (95% CI 9.0–35.4; $p = 0.01$) (Table S3). There was no evidence of an association was found for any of the other Apps, but caution should be taken due to the variable completion rates of these items.

3.4 | Mediation analysis

The parametric regression analysis found that there was a significant direct effect of problematic smartphone use on the presence of

anxiety (OR=1.92, 95% CI 1.20–2.91) and a significant total effect of the model (OR=2.24, 95% CI 1.41–3.44). There was a significant indirect effect via the mediator (OR=1.17, 95% CI 1.03–1.37; See Figure 1 and Table S4).

When considering the effect of problematic smartphone usage on depression, parametric regression found a significant total effect (OR=3.15, 95% CI 1.76–5.07) and direct effect (OR=2.58, 95% CI 1.55–4.00) There was a borderline significant indirect effect via insomnia (OR=1.22, 95% CI 1.03–1.47; See Figure 2).

TABLE 3 Association between demographics, smartphone usage and moderate depression (PHQ), using a crude and multi-variable mixed-effects logistic regression analyses presenting the crude odds ratio (OR) and adjusted OR (aOR) with 95% confidence intervals (95% CI).

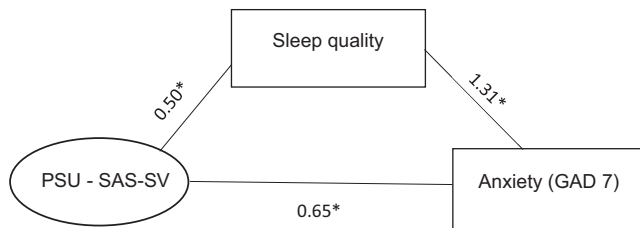


FIGURE 1 Estimates of coefficients for pathways in mediation model, with SAS-SV as the measure for problematic smartphone usage. The predictor is problematic smartphone use, the mediator is a binary measure of sleep quality (clinical insomnia present/absent) and the outcome is a binary measure of Anxiety (GAD). *Significant at p value <0.05 . PSU, problematic smartphone usage; SAS-SV, Smartphone Addiction Scale – Short Version.

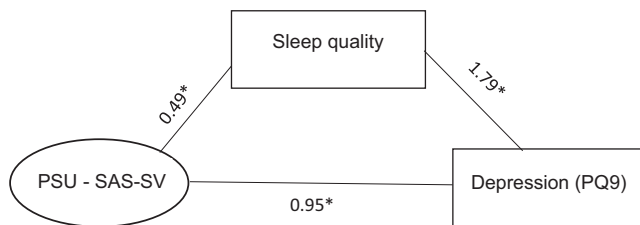


FIGURE 2 Estimates of coefficients for pathways in mediation model, with SAS-SV as the measure for problematic smartphone usage. The predictor is problematic smartphone use, the mediator is a binary measure of sleep quality (clinical insomnia present/absent) and the outcome is a binary measure of Depression (PHQ). *Significant at p value <0.05 . PSU, problematic smartphone usage; SAS-SV, Smartphone Addiction Scale – Short Version.

4 | DISCUSSION

In this study, we found an association between problematic smartphone usage and self-reported anxiety and depression, after accounting for insomnia and screentime in a large multi-centre adolescent sample. We found that the proportion of students with problematic smartphone use is highly variable across schools, from 13% to 43%, but the overall proportion of adolescents reporting problematic smartphone usage was 18%, with similar prevalence found in international studies.^{4,7} Furthermore, we show that there is a relationship between problematic smartphone usage and anxiety and depression, but *not* between screentime and anxiety or depression.

Our findings are consistent with other studies which have widely argued that self-reported duration of daily smartphone usage is not associated with harm, including anxiety, depression.^{6,10} However, there was strong association between anxiety, depression and problematic smartphone usage, raising the question of whether this is the more clinically relevant exposure. Our sample included 1 in 4 participants with symptoms of probable anxiety, this is consistent to a recent UK wide sample.²³

We have also started to answer the question of whether the smartphone is an addictive technological 'substance' or a delivery device

for addictive Apps, by examining whether time on particular apps was associated with problematic smartphone usage. We found a higher usage of both Instagram and TikTok in those that reported problematic smartphone usage compared to those who did not, whereas there was little suggestion of a difference in usage in WhatsApp, general gaming, or general Internet usage. An explanation could be due to the functionality of the Apps and, in particular, the variable reward schedule being used, which is similar to the variable reward schedule in gambling.²⁴ Lindström et al.²⁵ report the number of likes predicts satisfaction and happiness and similarly that social media activity increases after a post, suggesting anticipation of receiving a reward. We did not find an association with gaming. Possible reasons for this could include gamers preferring a larger format screen and hence not gaming on their smartphone and a female preponderance in the sample.

It has already been established that smartphone use is associated with insomnia.^{9,26,27} We investigated whether problematic smartphone use was associated with anxiety and depression via its effect on sleep. However, these findings show that after accounting the indirect effect via insomnia, problematic smartphone use is still associated with both anxiety and depression as a direct effect.

This limitation of using a simple term of screentime as the measure of exposure from smartphones has been previously reported as insufficient,^{4,10,11} whereas a validated instrument consistent with DSM-V should be used.

These findings also concur with the literature about adolescents seeking help to reduce their usage and employing to strategies to manage their screentime usage, we found the majority have used at least one strategy to manage their use. In a systematic review that included six studies of interventions to reduce problematic smartphone use, Malinauskas and Malinauskienė²⁸ offer early evidence suggested that group interventions of cognitive behavioural therapy or school based training programmes may be helpful in reducing problematic smartphone usage but highlight further research is needed. A randomised controlled trial found a combination of nudge-based reduction strategies (including keeping the phone on silent and faced down, disable non-essential notifications and hiding social media Apps) were acceptable and found to reduce problematic usage.²⁹

4.1 | Strengths and limitations

The study enrolled adolescents from five schools throughout regions of England and data were collected at scale, prior to the impact of a pandemic and subsequent lockdown. The prevalence of anxiety, depression and problematic smartphone use was consistent with other studies in this population. Weaknesses include the cross-sectional nature of the study meaning reverse causality cannot be excluded.

Given the ubiquitous usage of smartphone technology, this study supports that future research in affective disorders in adolescent population should include longitudinal studies where problematic smartphone use is measured using a validated instrument over time.

Future adequately powered clinical research is needed to evaluate whether reduction strategies can reduce anxiety and depression in adolescents with problematic smartphone use.

5 | CONCLUSIONS

Nearly 1 in 5 older adolescents reported problematic smartphone usage and almost 2 in 3 reported wanting to cut down their usage. Further research focusing on the direction of causality in the relationship between anxiety, depression and problematic smartphone usage and to evaluate interventions to reduce problematic smartphone use, is now required.

AUTHOR CONTRIBUTIONS

Ben Carter: Conceptualization; methodology; formal analysis; supervision; writing – review and editing; writing – original draft; project administration; investigation. **Mollie Payne:** Methodology; writing – original draft. **Philippa Rees:** Writing – review and editing. **Sei Yon Sohn:** Writing – review and editing; conceptualization. **June Brown:** Writing – review and editing. **Nicola J. Kalk:** Conceptualization; methodology; investigation; writing – review and editing.

ACKNOWLEDGEMENTS

We would like to thank Miss Abigail Marais who commented on the case report form from an adolescent perspective. We would like to thank the work of Lucy Wood, who collected the data from the schools and Miss Chloe Spriggs from King's Clinical Trials Unit, at King's College London, who entered the data. As well as Dr Philip Braude for administrative assistance. We would also like to acknowledge the contribution of Mrs Lizzie Beesley; Mrs Sandrine Paillasse; and Mrs Chloe Hardwick from St Paul's Girls School, Hammersmith.

FUNDING INFORMATION

This paper represents independent research funded in part by the National Institute for Health Research (NIHR) Biomedical Research Centre at South London and Maudsley NHS Foundation Trust and King's College London. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care (BC). NK's research time is supported by the NIHR Biomedical Research Centre for Mental Health at South London and Maudsley NHS Foundation Trust and King's College London. The funder had no role in the study design, data collection, data analysis, data interpretation or writing of the report.

CONFLICT OF INTEREST STATEMENT

All authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

Authors wishing to access the data should contact the corresponding author providing a statistical analysis plan addressing a new

research question. All requests will be discussed by the study steering committee.

ETHICS STATEMENT

Ethical approval was received from the King's College Research Ethics Office (Study ID: 9138; MRS-18/19-9138).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Carter B, Payne M, Rees P, Sohn SY, Brown J, Kalk NJ. A multi-school study in England, to assess problematic smartphone usage and anxiety and depression. *Acta Paediatr*. 2024;00:1-9. <https://doi.org/10.1111/apa.17317>