Income-related inequalities in informal care among older people in China

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Income-related inequalities in informal care among older people in China

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Statement of conjoint work

I confirm that Chapters 6, 7, and 8 were jointly co-authored with Dr. Wei Yang and Prof. Mauricio Avendano, who provided guidance on research ideas and empirical strategies and helped to revise these chapters. The introduction, literature review, econometrics analysis, discussion and conclusion were all written and carried out by me.

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Abstract

In both developed and developing countries, demand for long-term care (LTC) is expected to raise due to population ageing and increasing prevalence of disabilities. Research suggests that older people from lower income groups usually have poorer health outcomes and are less able to afford formal care than the better-off. Therefore, these older people are more likely to rely on care provided by family members.

Using China as a case study, this thesis draws on data from the Chinese Longitudinal Health Longevity Survey (2005-2018) to understand whether and to what extent receiving informal care influences older people's health outcomes and their use of health care services, and how these effects vary across different income groups. This thesis comprises three empirical chapters (Chapter 6, 7 and 8). Using concentration indices and random effects model, Chapter 6 provides a descriptive analysis on the distribution of informal care among older people across different income groups. Chapter 7 uses lagged fixed effects models to investigate the heterogeneous effects of informal care on older people's health across income. Chapter 8 uses a two-part model with instrumental variable approach to investigate the impacts of informal care receipt on older people's health care utilisation across income.

This thesis has a number of significant findings. Chapter 6 finds that there is significant pro-rich inequality in hours of informal care received among care recipients, even after controlling for need. The degree of the pro-rich inequality increases as the number of functional limitations increases. Chapter 7 suggests that receiving informal care significantly slows down the progression of functional limitations, but this protective effect is more pronounced among those with higher income. Chapter 8 shows that receiving longer hours of informal care substitutes outpatient care, but not inpatient care. Such a relationship does not vary across different income groups.

In conclusion, the thesis demonstrates that older people from lower income groups are less likely to receive informal care, consequently their functional abilities may decline faster compared to those from high income groups. Informal care also has significant implications on health care utilisation, especially for outpatient care. This thesis highlights the importance to address income-related inequalities in health by developing policies to support informal

care and to improve formal home- and community-based care services for older people from lower income.

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This thesis is dedicated to my grandparents and parents.

Table of Contents

List of tables

List of figures

List of abbreviations

ADL	Activity of daily living
CHARLS	China Health and Retirement Longitudinal Study
CI	Concentration Index
EI	Erreygers's Concentration Index
CLHLS	Chinese Longitudinal Health Longevity Survey
FE	Fixed effects
H	Hypothesis
HI	Horizontal Inequity Index
HSM	Heckman Selection Model
IADL	Instrumental activity of daily living
IV	Instrumental variable
LTC	Long-term care
LTCI	Long-term care insurance
NRCMI	New Rural Cooperative Medical Insurance
MAR	Missing at random
MCAR	Missing completely at random
MNAR	Missing not at random
MMSE	Mini-Mental State Examination
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Square
OOP	Out-of-pocket
PRC	People's Republic of China
RE	Random effects
RQ	Research question
SHI	Social health insurance
UEMI	Urban Employee Medical Insurance
UNECE	United Nations Economic Commission for Europe
URMI	Urban Resident Medical Insurance
US	United States of America
UK	United Kingdom
WHO	World Health Organisation

Note on the structure of the thesis

This thesis conforms to the requirements of a doctoral thesis from King's College London. Guidelines state the thesis should not exceed 100,000 words, with at least one paper published in a peer reviewed publication. Accordingly, Chapter 1 provides motivation, background and an overview of research questions. Chapter 2 provided a detailed background discussion of informal care in China. Chapter 3 provides a detailed overview of the conceptual framework that guided the analysis. Chapter 4 reviews the relevant literature and existing evidence in relation to the key research questions. Chapter 5 discusses the data and provides an overview of the overall empirical approach and methods. Chapters 6, 7 and 8 are presented in the style of journal articles and are thus termed 'papers'—form the main body of the thesis. All of these three papers have been published in peer-reviewed journals. Chapter 6/Paper 1 is published in Journal of Gerontology: Series B (Wang, Yang, and Avendano, 2021). Chapter 7/Paper 2 is a published paper in Research on Aging (Wang and Yang, 2021). Chapter 8/Paper 3 is a published paper in Social Science & Medicine (Wang, Yang, and Avendano, 2022). Chapter 9 presents policy recommendations, limitations of the study, as well as future research agenda.

Chapter 1. Introduction

1.1 Aims and objectives

The world is experiencing unprecedented population ageing, as a result of falling fertility rates and rising life expectancy. In 2019, there were 703 million people aged 65 years and over worldwide, a number expected to rise to 1.5 billion by 2050 (World Bank, 2019). This increase in the number of older people is expected to increase the demand for long-term care (LTC), which refers to services required by persons with a reduced degree of functional, physical, or cognitive capacities, who are consequently dependent on help with basic activities of daily living for an extended period (Ranci and Pavolini, 2011). LTC has therefore become one of the most critical policy areas to be address by health and social protection systems around the world (World Health Organisation (WHO), 2015).

Health outcomes vary across socioeconomic status (whether measured by income, education, occupational class or wealth). People with higher socioeconomic status tend to live longer and healthier lives, whereas people with lower socioeconomic status tend to have poor health and greater limitations in carrying out daily life activities, making them the most likely to require LTC services (WHO, 2015). Despite being more likely to require care, people with a lower socioeconomic status have less chances and resources to draw on as they age. They are less able to purchase formal care on the market, and are therefore more likely to rely on the informal care from family and friends (García-gómez et al., 2015).

Empirical studies have examined the distribution of informal care across socioeconomic groups, however, findings remain inconclusive. Some research shows that the lower socioeconomic groups have more barriers to receiving informal care. In particular, lower socioeconomic status may face greater distance to their children, pointing to a disadvantage to receive informal care. Their children may have less flexibility of time allocation decisions, and therefore face more opportunity costs if they provide intensive care (Ilinca et al., 2017). As a result, older people with lower socioeconomic status may be less likely to receive informal care. On the contrary, some studies indicate that filial obligations seem to be stronger among lower socioeconomic groups, leading to a higher probability of receiving care (Rodrigues et al., 2014). Most studies have used samples from Western countries to

investigate socioeconomic inequalities in informal and formal care use, while there is little evidence for developing countries in Asian.

In developed countries with a well-established LTC system, some public home- and community-based formal care services, such as personal care, are provided as the alternatives to informal care, thereby reducing family responsibility, especially among poorer individuals, who may be unable to afford private formal care (Floridi et al., 2020). By contrast, in developing countries, such as China, formal care is still in an early stage of development. Cultural norms, preferences and policies place a greater emphasis on the family as the primary carer (Hu and Ma, 2018), and governments have fewer tax revenue and financial resources to provide formal care services in the community (Du, 2015). Due to the lack of publicly subsidised care services and limited access to private care, older people with lower socioeconomic status in developing countries are more likely to rely on informal care. Yet, few studies have documented income-related inequalities in informal care in developing countries.

Among older people with higher income, family members may have more resources, information as well as knowledge in promoting health. They may be more likely to persuade older people to adopt positive health behaviours, better protecting them against functional and health decline (Pampel et al., 2011). By contrast, among those with lower income, family members may have limited knowledge of health and are less likely to be able to encourage healthy lifestyle. Consequently, older people from these families may have worse health status and more functional limitations. The disadvantages may accumulate in the long run, resulting in income-related inequalities in health outcomes.

The relationship between informal care and health care is a significant research topic. Older people with higher income may receive higher quality of LTC, so that their functional abilities decline at a slower pace, leading to decreasing need for care. By contrast, older people with lower income may receive less care even though they may have greater needs. This may lead to a higher risk of becoming dependent, having unfavourable health-related outcomes and incur higher costs for hospital care in the future. Therefore, a clear understanding of income-related inequalities in informal care receipt and its effect on health (e.g., health outcomes and health care use) provides useful insights and valuable knowledge for the development of policies to address health inequalities in later life.

In this thesis, I focus China as a case study to understand inequalities in informal care and its consequences for health inequalities in the context of developing countries. China has the world's largest population of older people and is experiencing rapid population ageing. The dominant value system in traditional Chinese society, Confucianism, emphasises the importance of family cohesion and filial piety. Under such a value system, older people in China with care needs are expected to receive help from family members as the primary choice. Meanwhile, people provide care to their parents or spouse, not only because of their emotional attachment but also because they feel a strong sense of obligation to do so as a member of the family (Hu and Ma, 2018). Despite the fact that the Chinese government has started investing in home- and community-based formal care, and policies relating to formal care provision have been put in place, utilisation of these services is still the exception rather than the norm in many parts of the country. Informal care continues to be the most important source of LTC in China, accounting for more than 90% of total LTC provision (Peng and Wu, 2020).

Futhermore, the rapid process of modernisation in China provides an interesting context to study income-related inequalities in informal care. Demographic, economic and cultural trends over the last decades increasingly challenge traditional Chinese values, impacting the availability of informal care differently for lower and higher income groups (Yang and Du, 2021). Those with lower income may face greater barriers to receiving family support, and the provision of affordable and accessible formal care and health care services to the lower income groups has been a source of concern (Du, 2015). As a result, the lack of availability of informal care, as well as access to formal care and health care, may place socioeconomically disadvantaged groups in further health disadvantage. The analysis of income-related inequalities in informal care and its implications for health in China can shed light on other developing countries, such as Thailand, Vietnam, and Cambodia, where informal care is the primary source of LTC and the society is experiencing rapid ageing.

Based on the above discussion, the overarching aim of this theis is to understand income-related inequalities in informal care receipt and its implications for health inequalities among older people in China. First, the distribution of informal care receipt among older people from various income groups will be examined. Second, the implications of inequalities in informal care for older people’s health outcomes and health care use will be examined. In particular, I

examine how informal care impacts older people's health decline and health care utilisation. Findings from this thesis highlight the growing need for government support aimed at vulnerable groups in society, such as low-income older people with functional limitations.

1.2 Thesis structure

This thesis is organised as follows. Chapter 2 sets out the background to the research topic. It starts by outlining the reasons why China has experienced unprecedented rapid population ageing, putting great pressure on care provision. It then discusses the importance of informal care in China and its influencing factors, including individual, family and society level factors. It ends by discussing the income-related inequalities in factors influencing informal care receipt. This is to demonstrate that low-income older people, who have greater care need, face greater disadvantages in the availability of care from family members, formal care and health care services in China.

Chapter 3 provides a detailed overview of the conceptual framework that guides the analysis. I critically examine the concepts of inequality and informal care. I use stress-buffering model, the disablement process, and the extension model of classic Grossman model of health demand to provide a conceptual framework to study the effect of informal care receipt on health outcomes and health care use across different income groups.

Chapter 4 reviews the relevant literature and existing evidence in relation to my key research questions. It critically examines studies on socioeconomic inequalities in informal care receipt; the effect of informal care receipt on physical and mental health; and studies on the effect of informal care receipt on health care utilisation. I focus on studies around the global from those from the United States (US) and European countries, to studies in China and other Asian countries. This chapter concludes with a discussion of why findings from studies are inconsistent, and how this thesis aims to address existing gaps.

Chapter 5 discusses the data and provides an overview of empirical approaches and methods. First, it discusses the Chinese Longitudinal Health Longevity Survey (CLHLS), the dataset on which this thesis is based. Second, it discusses the methods used for each empirical chapter, including: the concentration indices and random effects model, used to examine income-related inequalities in informal care; lagged fixed effects model, used to examine the

effects of informal care receipt on health; and two-part model with instrumental variable approach, used to investigate the causal effects of informal care receipt on health care utilisation.

Chapters 6 to 8 discuss the findings of the quantitative research. These empirical chapters share a common structure. They start with an overview of the research questions, research hypothesises, data, methods, results, and a discussion of the most important findings. Chapter 6 provides an empirical investigation of income-related inequalities in informal care receipt. It seeks to understand the degree of income-related inequalities in the probability of receiving informal care, in number of hours of informal care received, and whether the inequalities grow when number of functional limitations increases. It is published in Journal of Gerontology: Series B (Wang, Yang, and Avendano, 2021). Chapter 7 examines the effect of informal care receipt on functional limitations and depressive symptoms among older people. It aims to investigate the effect of receiving informal care on older people's health outcomes over time, as well as the effect of longer care hours received on health among care recipients, and to compare these effects across different income groups. It is published in Research on Aging (Wang and Yang, 2021). Chapter 8 examines the impact of informal care receipt on health care use among older people. It intends to examine the impact of informal care receipt on the probability of using health care, and the impact of informal care receipt on health care costs among health care users, comparing these effects across income groups. It is published in Social Science & Medicine (Wang, Yang, and Avendano, 2022).

Finally, Chapters 9 discuss the main findings of the three empirical chapters of this thesis in the context of existing knowledge, and their contribution to understanding income-related inequalities in health and care. It then discusses implications for public policies that address formal home- and community-based care, informal care and health care are. The chapter ends with a discussion of the limitations of this thesis and possible avenues for future research to understand inequalities in health and LTC in older age.

Chapter 2. Background

Informal care in the context of population ageing in China

2.1 Introduction

This chapter introduces the context of income-related inequalities of informal care in China. It is divided into three sections. The first section discusses the drivers for China's rapid population ageing and how this impacts China's health and LTC system. The second section discusses the importance of informal care in China and its influencing factors. The focus of discussion is on the development of formal LTC, the family-based care in traditional and modern society, and the individual, family and society level factors influencing the receipt of informal care among older people. The last section discusses the income-related inequalities in these factors influencing informal care receipt. The chapter provides the background for the hypothesis that low-income older people, despite having greater need for care, are less likely to receive care from family members and to use formal LTC and health care services in current China, putting them in further disadvantaged place in health.

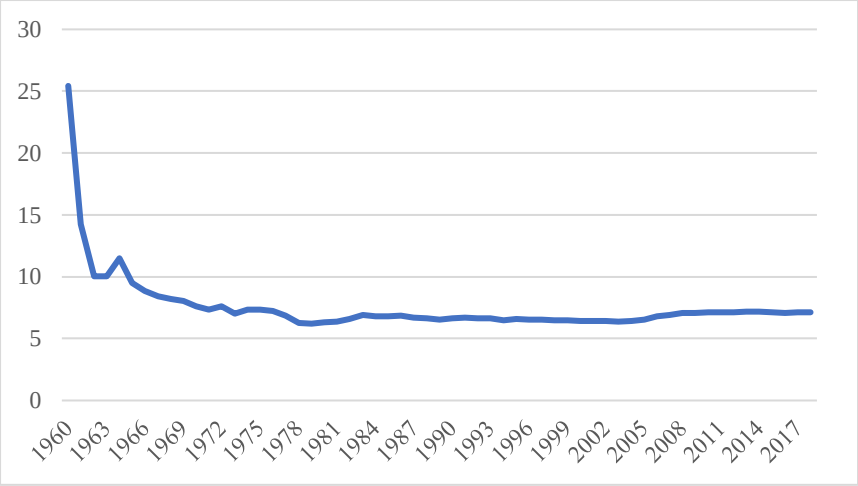
2.2 Population ageing in China

Population ageing is a global issue driven by improvements in life expectancy and declines in fertility (Dyson, 2013). China is no exception, but the evolution of population ageing in China is unique, shaped by its distinct historical, economic and political context (Chen and Liu, 2009).

The People's Republic of China (PRC) was founded in 1949. After years of wars with Japan and civil war, the new government faced many social problems, including poverty and inadequate sanitation. Such conditions posed a threat to health, leading to high prevalence of malaria, typhus and other infectious and parasitic diseases. Due to the lack of public health care provision, the crude death rate in 1950 was 195 per 1,000 people, while life expectancy at birth was 41 years, 5 years below the world average (Chen and Liu, 2009). Starting in the1950s, the new government sought to overcome these increasing health problems by a range of measures. They introduce policies to expanded immunisation/vaccination programs, established the Hygiene and Anti-Epidemic Station, and introduced 'barefoot doctors' (i.e., medical personnel with basic training to deal with hygiene matters and medical practice in rural China) (Lee, 2004). Meanwhile, with the popularisation of compulsory

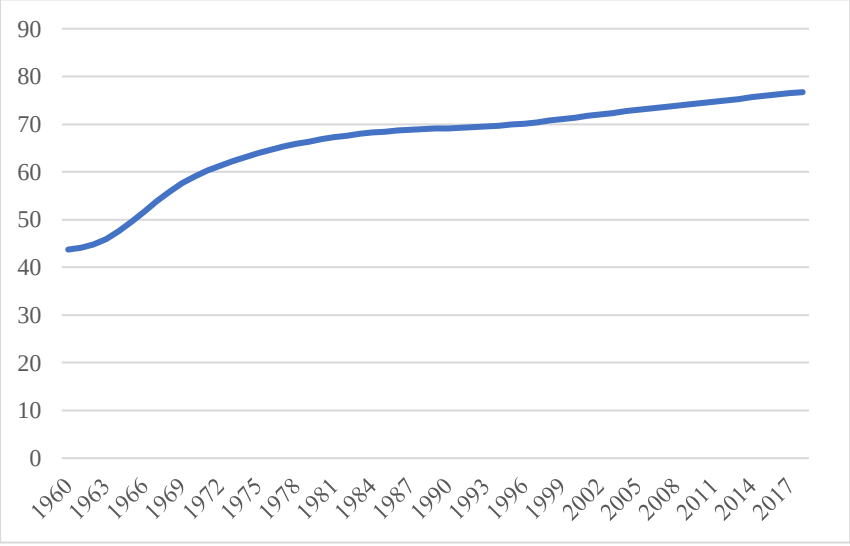
education, education levels in the population increased rapidly. Scientific knowledge of health management, disease prevention as well as the adoption of healthy lifestyle increased (Gui and Chen, 2020). By the late 1990s, China's health status had improved dramatically: the crude death rate was around 6.5 per 1,000 people and life expectancy was 70 years (See Figure 1 and 2). However, inequalities in crude death rate and life expectancy between low-income and high-income groups still exist. The crude death rate of low-income groups is 1.64 times that of hig-income groups (Xiao et al., 2022), and the life expectancy of high-income older people is 1.57 times that of low-income older people (Jiao, 2019).

Figure 1. Crude death rate per 1,000 people in China from 1960 to 2018



Source: https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=CN (available on 20/04/2021)

Figure 2. Life expectancy (at birth) in China from 1960 to 2018

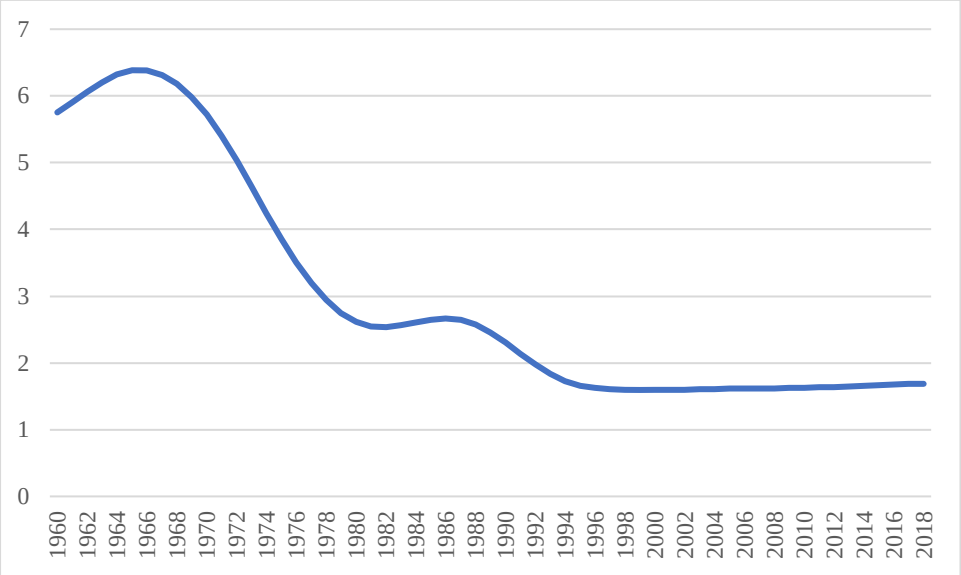


Source: https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=CN (available on 20/04/2021)

The onset of the fertility decline in China did not start until the late 1960s, almost two decades after the initial decline in mortality. The total fertility rate was still as high as 5.6 in 1950, and then fluctuated between the mid-1950s to early 1960s due to natural and human disasters, such as the famine and the Great Leap Forward (Chen and Liu, 2009). In 1960s, the government began to see the rapid population growth as a potential threat to the nation's economic development and food surplus. Policymakers advertised and popularised birth control in all densely populated areas, and encouraged planned pregnancies. At this point, fertility started to decline faster. In 1971, China started the *Wan Xi Shao* program. *Wan* refers to late marriage (mid-twenties for women, late twenties for men); *Xi* refers to long birth intervals/birth spacing (3–4 years); and *Shao* means fewer children (no more than two children per couple in urban, and three in rural areas). This program is believed to have left to a steep decline in the total fertility rate (Winckler, 2002).

In the late 1970s, China also launched its market-oriented reform policies, a major leadership shift. With economic development as the primary agenda of the country, the government was concerned with the detrimental effect of population growth on the country's limited resources. As a result, a stricter family planning program, known as the *one-child policy,* was launched in 1979. This program was a national system of economic incentives for one-child families and disincentives for larger families, with regional variations in implementation. The *one-child policy* was regarded as a huge success, and has been linked to a 70% decline in fertility in less than 20 years, the fastest decline in the history of China (See Figure 3). *The one-child policy* was gradually relaxed over the last decade, and ultimately abolished in 2015. However, the end of this policy has had little effect on increasing fertility, which continues to be very low (Yang and Du, 2021).

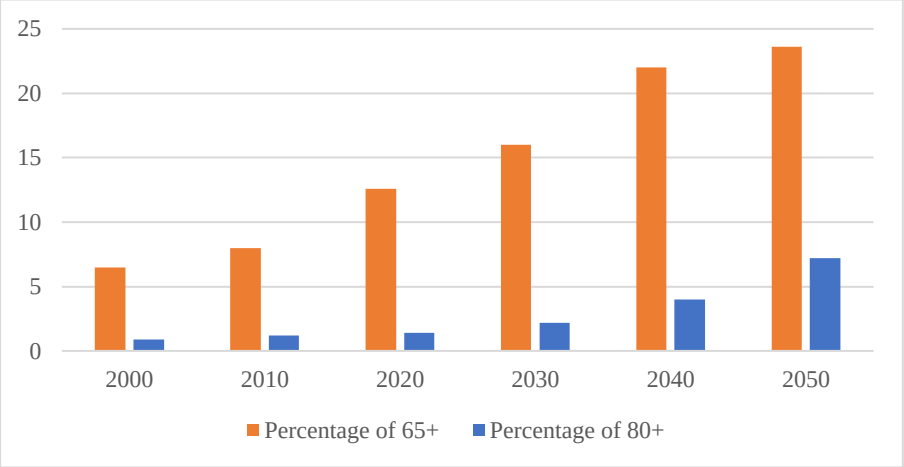
Figure 3. Fertility rate in China from 1960 to 2018



Source: https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?locations=CN (available on 20/04/2021)

With the drastic reduction in mortality and fertility and increase in life expectancy, the pace of population ageing in China accelerated (WHO, 2016). For example, while it took 115 years for the fraction of older people in France to increase from 7% to 14%, this happened in China over 27 years (Lou and Ci, 2014). In 2000, there were 87 million older people aged over 65, accounting for about 7% of the total population, suggesting that China had become an ageing society (Lu and Liu, 2019). Since then, the proportion of older people has increased throughout the years and is projected to continue increasing in the future. Figure 4 shows the projection of the proportion of older people aged 65+ and 80+ in China in 2000–2050. In 2020, the number of older people reached 176 million (12.6 % of the total population). Under the United Nations' medium fertility and mortality assumption, the proportion of older people in China will quickly rise to 23.6% of its population by 2050. Given the sheer population size of China, this figure will translate into 329 million older people in 2050, a number that is 10% larger than the size of the current US population (United Nations, 2019). Moreover, it is noteworthy that the growth of the oldest old (defined as older people aged 80+) population will be most dramatic in the coming decades. The proportion of the oldest old has grown from 0.9% in 2000 to 7.2% in 2050; and the share of the oldest old among those aged 60+ will increase from 13% to 30% from 2000 to 2050.

Figure 4. Projection of the proportion of older people aged 65+ and 80+ in China 2000–2050



Source: Chen and Liu (2009)

A fast increase in the number of older people with longer life expectancy may cause an increase in the number of older people suffering from functional limitations, chronic diseases and poor self-rated health. This is particular the case if increases in life expectancy are accompanied by a slower increase or even decrease in health life expectancy. Evidence suggests that the duration of difficulties in performing daily activities and severe morbidity increased from 2000 to 2010, especially among the oldest old (Liu et al., 2021; Lu et al., 2019; Zheng et al., 2020). If this trend remains continues, the number of older people with functional limitations is projected to increase to 68 million in 2030, 97 million in 2050 and surpass 100 million in 2053 (Lu et al., 2019). This means that the need for care will increase dramatically in the future, putting great pressure on both families and government.

2.3 Informal care in China

2.3.1 Informal care is the most important source of LTC in China

2.3.1.1 Development of institutional care

LTC is a range of services provided by informal or formal carers, at home or in communities or in institutions, to people who are dependent for an extended period of time on help with functional limitations (Ranci and Pavolini, 2011). After the establishment of PRC in 1949, the responsibility of providing LTC to older parents rested primarily on family members; the government only took care of older people who qualified as *'Three Nos'* (i.e., urban people with no children, no ability to work, and no source of income) or '*Five Guarantees*' (i.e., disabled rural people who have no income, no children or relatives to take care of them).

In rural areas of China, the government funded LTC welfare institutions as the place for institutional care for older people, with the exception of veteran hospitals that accept needed and/or retired veterans (Wu et al., 2008). After the market-oriented reforms in 1978, the social welfare system experienced dramatic structural changes. The government has no longer taken the sole responsibility of caring for older people, business, charities and families are all responsible for costs of LTC welfare institutions. In some areas near larger metropolitan areas, an increasing number of LTC welfare institutions have started to accept other older people who pay fees by themselves or their family (Wu et al., 2008). Service users are typically provided with a furnished room, together with meals, housekeeping and laundry services. Assistance with daily activities, such as dressing, eating and walking, is also provided. In addition, the supply of nursing homes and long-term acute care facilities have started to increase in recent years. Nursing homes are aimed at providing continual nursing care for those with severe functional limitations. Long-term acute care facilities are intended for providing specialised treatment to those with serious medical conditions that require care on an ongoing basis but no longer require intensive care or extensive diagnostic procedures (Yang et al., 2016). In the 2010s, the government implemented a series of policies to encourage the private sector to develop institutional care. The number of nursing home beds in China has increased annually by an average of 10%, reaching more than 7.46 million beds in 2019 (Sun et al., 2020).

The development of LTC in institutions is faced with many challenges. The lack of well-defined eligibility criteria makes it difficult to guarantee efficient service provision to those with urgent care need. Many nursing homes do not have a clear requirement for need assessment for admission, and access to services is based on ability to pay. A large proportion of older people in need who cannot afford expensive fees cannot get access to institutional care (Wong and Leung, 2012). Besides, although some local governments provide financial support to those who have severe need but are not able to pay, it is only applicable in limited areas due to insufficient funding. Therefore, lack of financial protection for LTC services for the general population and high costs are access barriers for many older people (Yang et al., 2016). In addition, even if older people in need have the ability to afford expensive fees, the quality of institutional care is a concern. Owing to lack of professional skills, less than 40% of nursing homes provide professional care services in urban areas, and specialised nursing homes for older people with functional limitations are almost inexistent in rural areas (Du, 2015). As a result, most Chinese older people see institutional care as the last resort. There is

also social stigma associated with being admitted to a nursing home, as it gives older people a sense of being abandoned by their family (Zhan et al., 2006). They prefer to age in their own homes, as it provides them with a sense of attachment, security and familiarity (Wiles et al., 2012). The vacancy rate of nursing homes is as high as 50% in 2020 and care in institutions accounts for only a small proportion of all LTC care in China (Du et al., 2020).

2.3.1.2 Development of home- and community-based care

Because most older people prefer to live at home rather than in institutions, the Chinese government has shifted their focus from institutional care to home- and community-based care in recent decades. A notable example is the Star Light Project, which started in 2001, and aimed to establish community-based centres as a platform to provide services, such as meals-on-wheels, help with bathing, as well as emergence assistance (Feng et al., 2012). From 2001 to 2003, a total of 32,490 community-based centres were built, with an investment of 13.48 billion yuan, benefiting over 30 million older people (Wong and Leung, 2012). In 2006, the government provided a blueprint for care for older people, informal care as the fundamental support, home- and community-based care as the necessary support, and institutional care as the supplementary support (State Council, 2011). Later, home- and community-based was formally recognised as a critical component of the social care system in the Chinese Government's 12th Five-Year Plan in 2011. In accordance with such policy, many cities adopted the following model in constructing their LTC systems: 90% of care is expected to be from family members, 6% or 7% of care is from home- and community-based centres, and 4% or 3% of care from institutions (Hu and Li, 2018). More recently, a new type of home- and community-based care, called virtual nursing homes, has arisen. Built on information technology, nursing homes can provide various services for older people at home, from cooking to monitoring their blood glucose and blood pressure, enjoying personalised and convenient care without leaving home (Feng et al., 2012).

Nevertheless, the utilisation of these types of care is much lower than that in high-income countries and regions, which is due to some problems in services and payments. Resources in home- and community-based care are not allocated by the government via service targeting. A large proportion of older people without functional limitations are service users, while the number of beneficiaries who is in need of care is relatively small (Zhou and Walker, 2016). Besides, due to the strict eligibility criteria for government support, few older people receive

publicly funded care, whereas most people must pay for care themselves or rely on financial support from families (Hu and Li, 2018). In addition, it is short of professional medical, nursing as well as rehabilitative services. Many staff at service centres are laid-off or early-retired factory workers, most of whom do not have formal geriatric training and skills (Chen and Han, 2016).

2.3.1.3 Development of informal care

In light of the underdeveloped institutional care and home- and community-based care system, care responsibility relies heavily on family members. As a result, informal care is the most important source of LTC in China, accounting for over 90% of total LTC provision (Du, 2015). The pivotal role of informal care is not only associated with formal LTC but also with the particular historical and cultural context. As a fundamental idea in Confucianism, filial piety has been highly valued as the basic rules for intergenerational relationships in traditional Chinese society. It generally consists of four components, showing respect to parents, concern for parents' health, giving parents' financial support, and fulfilling the need of parents (Hsueh, 2001). Zimmer and Kwong (2003) argues that influenced by filial piety, family members care about each other, they have selfless concern for one another and are therefore motivated to provide support. Traditional intergenerational support is motivated primarily by altruism, with the belief that help is given to those family members who are most in need but are unable to return the favour (Du and Wang, 2017).

During the process of rapid modernisation and socioeconomic development in China, filial piety has been challenged. In some families, older people are regarded as burden, and adult children do not visit them regularly, even treat them badly (Bai et al., 2016). Fear of the demise of filial piety, the Chinese government has made this proud traditional value become a part of the legislation in recent years. Both the Constitution of the PRC and the Law on Protection of the Rights and Interests of Older People of the PRC stipulate that adult children living apart from their older parents should frequently visit and look after their parents. Adult children should ensure that older parents who are sick receive care in time. Those who are unable to care for their parents in daily life should provide financial or emotional support to them instead (National People's Congress of the PRC 2004, 2013). Those who fail to fulfil the duty of filial piety may be criticised in moral terms or sanctioned in financial terms (Hu and Ma, 2018). Furthermore, many local governments have related policies to encourage

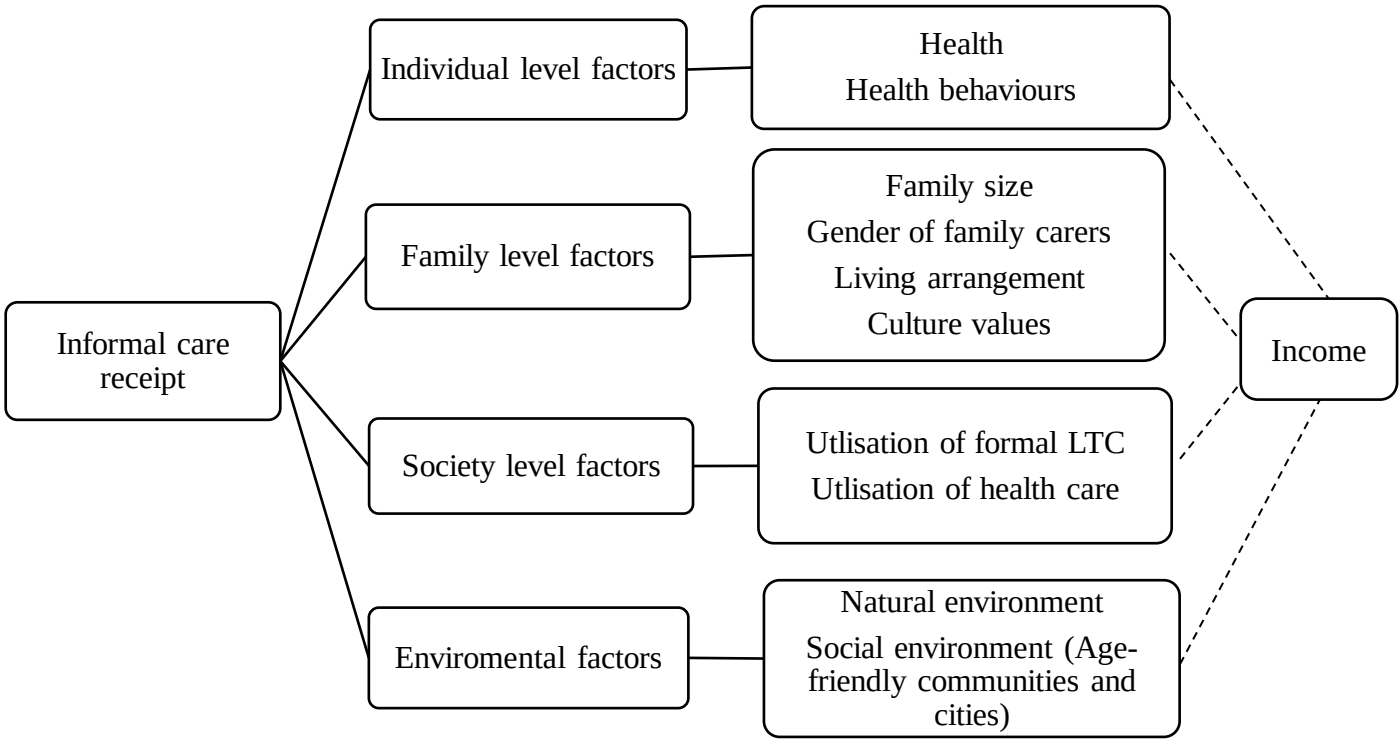
adult children to fulfil their obligations to older parents (Du, 2015). In 2016, the Beijing government approved a plan to call for an age-friendly city, including a recommendation that businesses and other employers give their employees 'filial piety holidays'. This is designed for visiting their older parents and assisting them in daily activities. The Shanghai government introduced filial piety into social credit system, for example, assessing the frequency with which adult children visited their parents and whether their parents had enough food (Chen and Cheung, 2017). If adult children break the rules, their creditworthiness will decline in the future. These laws and policies are building on traditional values of respecting and caring for older parents.

Due to the fact that it takes time to develop formal LTC systems, and preferences for informal care are unlikely to change drastically in the short-run, informal care is likely to remain the foundation of LTC systems in China for the years to come. Specifically, for older parents, their primary choice of receiving care from family members is likely to continue. This may include the expectation of their family members to show concern, live with them, and help them in daily life. The provision of care to a spouse or older parent in need is thus likely to remain a moral obligation and a highly desirable practice and belief (Lai, 2010).

2.3.2 Factors influencing informal care receipt in China

Based on studies on informal care (Du and Wang, 2017; Hu and Ma, 2018; Peng et al., 2017), I divide the potential factors affecting the receipt of informal care into three groups: individual, family, and society level factors (See Figure 5). This section focuses on how these factors influence informal care receipt; the following section 2.4 will focuses on how income inequality influences these factors.

Figure 5. Factors influencing informal care receipt



2.3.2.1 Individual level factors

Numerous studies show that an individual's need is the direct reason for receiving informal care (Hu and Ma, 2018; Wolf, 2014). It is often measured by health status, such as number of functional limitations, number of chronic diseases, cognitive functioning, and self-rated health (Suanet et al., 2012). Without considering other factors, such as socioeconomic factors, the worse health status, the more informal care the individual is expected to receive (Hu and Ma, 2018). Because unhealthy behaviours may lead to worse health status, they may also indirectly increase need and the demand for informal care. For example, smoking increases the risk of lung cancer, heart disease and stroke; and alcohol consumption increases the risk of liver disease and brain damage (Cheon et al., 2014). These behaviours may translate into worse health status, leading to higher need for LTC.

2.3.2.2 Family level factors

Family level factors in traditional Chinese society

Family level factors refer to the availability of family support. The term 'family' is used broadly to refer to persons who are united by the ties of marriage, blood, or adoption (Zeng, 1991). Traditionally, multigenerational co-residence is the cornerstone for family members to

provide care to older people in China. A Chinese family usually includes at least two generations, i.e., parents and children living together. It is common for several generations living in the same household, which is convenient for adult children to provide care in daily life. Deeply influenced by Confucianism, the altruistic motivation implies that the family acts as a corporate unit, with resources pooled and efficiently distributed to guarantee the survival of the head and each family member (Becker, 1974). Empirical studies provide the evidence that filial piety plays a special role in altruistic model in traditional Chinese family (Zimmer and Kwong, 2003; Brasher, 2021). In particular, care for older parents is seen as a moral obligation. Older parents who are the most needy receive the greatest volume of support from family members, even if they have little to offer in return (Lai, 2010). Furthermore, providing care for parents remains an expected responsibility of sons in traditional patrilineal Chinese society. Specifically, married sons and daughters-in-law act as the primary carers to parents, while married daughters are expected to care for their husband's parents (Zhang and Harper, 2022a).

Changes in family level factors in modern Chinese society

Over the past 70 years after the founding of the PRC in 1949, the changes in demographic characteristics, economic development, as well as culture values have jointly brought about dramatic changes to Chinese society. Changes in family, as a basic unit of society, have had tremendous influence on traditional intergenerational support (Yang and Du, 2021). Below, I discuss these changes and why they are important for understanding informal care in China.

Changing family structure

The *one-child policy* in 1979 brought changes in demographic characteristics and families. The steep decline in fertility has resulted in fewer children in almost every family. Since 1980, the size and proportion of one-child families has increased, especially in urban areas. In 1980, 25.18% of urban women aged 50–59 had both a son and a daughter, 40.60% of them had only a son, and 30.48% of them had only a daughter (Hu and Peng, 2015). The *one-child policy* is believed to have contributed to these reductions in family size (See Table 1). In the early 1970s, the average family size peaked around 4.8, after which it began to decline at almost the same time as fertility rates, dropping below 4.0 in 1990 and 3.09 in 2010. In 1982, a family of four to five persons was most prevalent, and a family of six and more persons accounted for 28% of the total families. Such large size of family is no longer typical since

1990. A family of three persons became the most common type of family, increasing to around 30% in 2000. By 2010, this percentage declined slightly to 27%, but this was mainly owing to the increases in one-person family and two-person family (Hu and Peng, 2015).

Table 1. Changing trends in the family size in China from 1990 to 2010

Year	1-person household (%)	2-person household (%)	3-person household (%)	4-person household (%)	5-person household (%)	Average household size (person)
1990	6.27	11.05	23.73	25.82	33.13	3.96
2000	8.30	17.04	29.95	22.97	21.73	3.46
2010	13.66	24.37	26.86	17.56	16.66	3.09

Source: Hu and Peng (2015)

With an increasing number of children from one-child families reaching adulthood, the probability of marital unions between only-children has increased, leading to the so-called 4-2-1 family structure (four grandparents, two parents, and one child) (Jiang and Sánchez-Barricarte, 2011). This family structure brings a series of challenges to family support. Specifically, the middle generation, two parents, have to be responsible for both the care of one child and up to four grandparents, and some may even have surviving great-grandparents. This means that one person in the middle generation has to support two parents and possibly four grandparents, as well as participating in the labour market. Moreover, the only child in the middle generation has often no siblings with whom to share filial duty. When parents in the middle generation get older, the only child in the third generation will have to support two parents and all four grandparents (Phillips and Feng, 2015). A fast decline in family size puts much heavier burden on potential carers, threatening the sustainability of family support in the future.

Rural-to-urban migration

The market-oriented reform has fuelled economic growth in recent decades, making China one of the largest economies in the world. One of most striking phenomena is the expansion of labour markets: with more diversified employment opportunities, a large number of rural labour forces have migrated to eastern coastal areas, and traditional family support has challenged (Zhang, 2018).

Rural-to-urban migration has diminished many adult children's ability to support their older parents in rural areas, due to the *hukou* system, the household registration system in China,

which requires every Chinese citizen to be registered at birth with the local authorities as either urban (non-agricultural *hukou*) or rural (agricultural *hukou*) householder. This system has long been recognized as an 'invisible wall' between the rural and urban areas when allocating resources, such as education and health care. Since this system did not restrict the migration of labour, metropolitan areas and cities in the coastal areas usually have high proportions of migrants who live and work in urban areas without changing their agricultural *hukou* status. Yet, the *hukou* status restricts their access to resources and benefits in the cities. For example, the health services they use in cities are generally not covered by their health insurance network in rural areas. Owing to the *hukou* restrictions, they are even likely to be discriminated against and their lives are extremely vulnerable (Zhang, 2018).

As a result, the migration of their entire family is not feasible, leading to a large number of left-behind older parents in rural areas. With the continuous outflow of adult children, the long distance to their older parents creates difficulties in providing day-to-day care. There has been increasing number of empty-nest older people whose children have already left home and thus live alone or with their spouse. It is estimated that the proportion of families with empty-nest older people will reach 90% of all families in China by 2030 (Zhang et al., 2020).

International migration

In addition to internal migration, international migration has become a common experience in modern society (Guo et al., 2018). China, the most populated country in the world, has also witnessed massive international migration of young adults since the post-1978 economic reform. For example, China ranked as the top (non-European Union) migrant-sending country to the United Kingdom (UK) in 2012 (Tu, 2016). This trend has raised concerns about how to care for older parents who are left behind in China. Although financial support is often provided through gifts and remittances, care in daily life can only be provided when adult children return to their home country or when their parents visit them (Xu et al., 2018).

Female labour force participation

The rapid economic development also challenges traditional intergenerational support owing to the growing number of women participating in the labour market. Over the past few decades, the Chinese government has made women's career engagement as a priority, and a series of laws and policies have been put in place to protect their employment rights and

interests (Yang and Zhang, 2020). Both the Constitution of the PRC and the Marriage Law of the PRC stipulate that women have the freedom and have equal rights with men to choose a career, to take part in labour market and to participate in social activities. With rapid economic growth, there are diversified employment choices for women, giving them more opportunities to become entrepreneurs and innovators, and the number of women employed or starting a business has increased significantly (Xi, 2017). From 1978 to 2016, the number of women formally employed in urban areas increased from 31.28 to 65.27 million; the number of women employed in the finance, scientific research as well as high technology fields increased from 0.45 million to 5.79 million (Yang and Zhang, 2020). However, more job opportunities have heightened the tensions between women's dual roles as employees in the labour market and informal carers in the family (Tong and Zhou, 2013).

Economic growth, together with privatisation and commercialisation of care services, have led to a rapid expansion of markets for domestic and personal care services. Female rural-to-urban migrants account for the majority of paid domestic workers in cities. However, in China, the domestic service market is poorly regulated, characterised by low pay, long working hours, and difficulties in access services such as healthcare and housing in urban areas (Cook and Dong, 2011). The combination of more time for work and long distance between adult children and their parents has challenged traditional family support in rural areas. Thus, the development of domestic and personal care service markets might lessen part of care burdens among women in urban areas, but to a large extent reduces time for day-to-day care for older parents among women in rural areas (Xi, 2017).

Gender difference of informal carers

Studies suggest that females, including female spouse, daughters and daughters-in-law, are more likely to provide care to family members in modern Chinese society (Chen et al., 2018; Yang et al., 2021). When there is a spouse present, females are more likely than males to care for the spouse (Chen et al., 2018). Along with the implementation of the *one-child policy*, some families only contain a daughter, with the increasing popularity of daughters providing support to their natal parents (Zhang and Harper, 2022b). Studies provide the evidence that daughters and daughters-in-law are more responsive than sons to traditional beliefs regarding adult children's filial obligations (Yang et al., 2021). Daughters and daughters-in-law are primarily responsible for support in daily living and emotional support, whereas sons are

mainly responsible for providing financial support (Quashie, 2015). Studies show that parents are more satisfied with care provided primarily by daughters and daughters-in-law than by sons (Zeng, 2016). However, as mentioned earlier, with the repaid economic growth, an increasing number of female family carers, who assume main responsibility for daily care, participate in the labour market, reducing the availability of informal care.

Changing traditional culture values

The process of modernisation has also brought enormous changes in culture, which undermine traditional values of filial piety. Western value of individualism has increased among young people since the 1980s. It encourages young people to pursue their own interests without regard for the rights or need of others. (Liu and Kendig, 2000). Some Chinese young people tend to promote their individual rights in challenging the authority of parents and in failing to exercise traditional bonds of filial obligation, which makes changes on traditional intergenerational support (Qi, 2015). Therefore, the exchange motivation may predominate over the altruistic motivation in intergenerational relationships in modern society. Some studies support this argument by providing the evidence that adult children's unconditional willingness to care for their parents is declining; instead, they care for their parents in anticipation of older parents caring for grandchildren or future transfers (An, 2019; Liu, 2015).

In conclusion, social changes have remoulded intergenerational relationships. Demographic changes, economic development and changes in cultural values have brought considerable challenges to family's ability to support older people. Combining with reducing fertility, industrialisation, urbanisation and migration, the number of potential informal carers has declined, as the demand for care by older parents has increased. As the middle generation in the 4-2-1 family, adult children devote most of their time to work and to look after their only child, resulting in less time to care for their older parents, who may live far away. Higher participation in the labour market rates among female adult children, who often take up the main responsibility of caring for parents, will have a profound impact on the availability of family support.

2.3.2.3 Society level factors

Formal LTC utilisation

During recent decades, the Chinese government has assumed increasingly responsibility by providing formal LTC (institutional care and home- and community-based care). They have done so by diversifying services, such as assistance in daily activities, chronic disease management, rehabilitation services and medical services (Hu and Li, 2018). Empirical studies provide the evidence that the availability of formal care may influence the receipt of informal care, and this relationship is likely to vary depending on the type of formal care used (Bonsang, 2009). In particular, formal care that requires low level skills is likely to be a substitute for informal care. For example, with assistance in daily activities from community, older people's care need is likely to be satisfied, leading to less tendency to seek support from family members. However, this substitution effect may not apply to formal care demanding higher level skills. For example, when older parents use medical formal care services, they may require more assistance from family members at the same time to help them identify errors in medications or quickly notify medical staff of problems (Lin, 2019).

LTC insurance (LTCI) system is another essential component in influencing informal care receipt. Compared to developed countries, LTCI in China is still in the initial stage of development. The Chinese government launched the first LTCI scheme in Qingdao as the first pilot city. In 2016, the scheme was expanded to fifteen cities with a growing ageing population (Zhu and Österle, 2019). Insured older people can usually choose home-based care, community-based care, or institutional care, enjoying services through subsidies determined by a budgetary quota. Although the benefit packages (e.g., target population, reimbursement level, and covered services) are diversified in pilot cities, LTCI is perceived as having an active role in accessing formal LTC services within limited costs (Yang et al., 2020). Some studies find that the public LTCI system has a positive effect on health, decreasing the need for informal care (Chen et al., 2020).

However, as mentioned earlier, the development of institutional care and home- and community-based care is still in its infancy. Due to the strict eligibility criteria for government support, the number of older people who require care and receive publicly funded care is relatively small. Because of the limited benefit packages, a large number of care-dependent older people are denied access to formal care when they are unable to meet

the costs people (Yang et al., 2000). As a result, family is still expected to assume the main responsibility of caring for older people in the short run in China, and there is still much work to be done to establish a comprehensive LTC system that is both financially viable and affordable to the public purse.

Health care utilisation

Similar to formal LTC services, health care utilisation may also influence the receipt of informal care. By receiving professional and effective treatment, older people's health may be maintained or improved, reducing need for daily care from family members. Previously, high payments by patients or their families created a barrier to access. The government established social health insurance (SHI) as the countrywide public-subsidised insurance system to generate substantial savings for each patient. After many years of health care reform, around 95% of older people participate in at least one of the following three schemes: the Urban Employee Medical Insurance (UEMI), covering urban residents with formal employment; the Urban Resident Medical Insurance (URMI), covering urban residents without formal employment; and the New Rural Cooperative Medical Insurance (NRCMI), covering rural residents (Du et al., 2017). Despite the differences in these fragmented schemes, more insured older people have access to medical care services (Yang and Wu, 2017), which may influence their need for informal care if their need is met.

2.3.2.4 Environmental factors

Environment is another important factor influencing the receipt of informal care, including natural and social environment. The natural environment generally includes, but is not limited to, air quality, community afforesting, and environment on rainy and snowy days (Zhang & Li, 2019). Studies show that better natural environment is associated with lower risks from natural disasters, improved physical and mental health, and lower risks of mortality and of chronic diseases, such as cardiovascular disease, which may influence the need for informal care (Habib et al., 2020).

With rapid population ageing, the WHO has proposed the goal of age-friendly cities and communities to help older people stay independent and healthy for as long as possible. Specifically, there are eight domains in the field of the social environment: outdoor spaces and buildings, transportation, housing, social participation, respect and social inclusion, civic

participation and employment, communication and information, and community support and health services (Van Hoof et al., 2021). In response to WHO's initiative, some large cities in China have implemented the age-friendly cities programme. For example, Shanghai promotes the quality of neighbourhood environment in urban communities, develops safe and liveable environment for older adults living alone and those with functional limitations (Lu and Wu, 2022). Studies show that age-friendly cities and communities address some health-related issue, such as pollution and traffic noise, and help older people develop healthy behaviours, such as more frequent physical activity (Neal and DeLaTorre, 2016). Such benefits are found be associated with lower risks of illness and diseases, higher quality of life, and longer healthy life expectancy (Flores et al., 2019; Zhang and Li, 2019), reducing the need for informal care.

In conclusion, China has one of the fastest growing ageing populations in the world. Traditionally, family has been the cornerstone of social support for older people. During the process of modernisation, the decline in the number of potential carers in families, internal and international migration, women participation to labour market, and the change of family member's caregiving willingness have reduced family's ability to provide care. Meanwhile, the government has assumed more responsibility to relieve burden on the family. Formal LTC and health care services have been provided to ensure needy older people receive high quality of care. Age-friendly cities and communities have been proposed to help older people maintain independent and healthy. However, there is still a long way to go to improve formal care, so that family members, especially female spouses and daughters, remain the primary source of care for older people.

2.4 Income-related inequalities in factors influencing informal care receipt in China

Chinese citizens were promised egalitarian distribution of resources and cradle-to-grave welfare coverage during the central planning era in the 1950s – 1960s (Li, 2012). Following the end of socialism, the role of central planning declined while the role of markets and private enterprises increased. With the transition to the market economy, income inequality has grown gradually. The Gini coefficient increased from 0.30 in the 1980s to around 0.47 in 2014, making China one of countries with higher income inequality in the world (Han et al., 2016). Along with rapid population ageing, income inequality among older

people has received more attention (Zhu and Fan, 2017). A series of social changes embedded in the context of modernisation have impacted different income groups unevenly, and thus, income-related inequalities has become one of the major social concerns. This thesis focuses on the potential impact of these inequalities on the distribution of informal care receipt by income.

2.4.1 Income-related inequalities in health

Generally, individuals' socioeconomic status is closely related to their access to key resources, including knowledge, money, power, social relations, health behaviours and medical interventions, which may reduce the risk of disease and increase the likelihood of disease treatment (Liu and Zhang, 2019). Socioeconomically advantaged groups often have better knowledge to avoid disease, healthier behaviours to reduce risks, and more opportunities for effective medical intervention (Jiao, 2019). Many studies find that there is a pro-rich inequality in health outcomes among older people, even after controlling for education, occupation and other socioeconomic and demographic factors (Feng et al., 2013; Gu and Xu, 2007; Sun et al., 2020; Zachary and Julia, 2004). For example, compared with older people with higher income, those with lower income have more functional limitations, more chronic diseases, and poorer self-rated health. Although this pro-rich inequality in health may be the result of the impact of income on health, the impact of health on income or the impact of other confounding factors, these studies provide important insights into the magnitude of income inequalities in health, indicating that those with lower income have greater need for care.

2.4.2 Income-related inequalities in availability of family support among older people

During the process of modernisation, economic development and changes in cultural values have posed challenges to income-related inequalities in intergenerational support. With rapid economic growth, there has been large-scale migration of younger workers, from rural to urban areas, affecting many poor families concentrated in remote rural places or minority regions (Wang and Cai, 2007). In particular, increasing number of labourers in low-income families, both males and females, have left poor counties to work outside, leaving their parents behind, creating barriers to accessing informal care. By contrast, adult children from

high-income families may have more resources for their parents to migrate with them, or they may not need to migrate to distant places (Démurger, 2015).

In addition, the majority of adult children in poor families are employed in production line work in destination cities (Chen, 2009). Empirical studies find that those less-skilled workers have less flexibility with their scheduled hours or location than do more highly-skilled workers; in order to have higher salaries and provide more financial support to family, they tend to spend more time on work, crowding out time on care for older parents (Cook and Dong, 2011). On the contrary, empirical studies show that adult children in rich families are more flexible in their time allocation decisions (Chen, 2009; Qian, 2017). Compared to adult children in poor families, those in rich families are found to have higher education level, making up a higher proportion of managerial or professional workers and a lower proportion of production line workers. Cook and Dong (2011) argue that with more flexibility to change their work arrangement, time and location, they spend more time caring for older parents. Thus, older people with higher income are expected to receive more care from adult children, while those with lower income, who have stronger need for care, are expected to receive less care from adult children.

Moreover, changes in social values have further decreased the availability of informal care for low-income families. Western value of individualism presupposes that caregiving is essentially a service rendered by a carer regardless of the nature of social ties. As a service, it is based on voluntary exchange between the carer and the recipient of care (Liu and Kendig, 2000). According to the exchange motivation, some studies show that adult children's decision to provide care is motivated by their expectation that their older parents will provide monetary transfers, including bequests, which would offset the perceived burden of caregiving (An, 2019; Liu, 2015). Compared to older people with higher income, those with lower income face more disadvantages in receiving informal care because they can only afford to give adult children limited gifts or money.

2.4.3 Income-related inequalities in formal LTC and health care utilisation among older people

In recent years, the Chinese government has made great effort to satisfy need of older people by providing formal LTC and health care. However, the expansion of service capacity has

been highly uneven across the country, owing to different economic development and financial investment (Du et al., 2021). Regions that are more economically developed have more tax revenue, and local governments have more financial resources to develop services. The central government provides additional funding to large cities and provincial capitals in the hope that the care services in these cities will serve as a model for the rest of the country (Jia et al., 2014). Differences in funding result in a great divide in care availability: while the number of providers has increased greatly in provincial capitals or large cities, institutional care facilities and home- and community-based care services remain scarce in poor rural counties and villages; there are less than half as many hospital beds and licensed physicians per 1,000 people in poor rural counties compared to large cities (Fang et al., 2019). Studies show that it is more difficult for older people with lower income who are more concentrated in rural counties and villages to get access to formal LTC and health care services (Yang et al., 2020).

In addition, empirical studies show that current LTC and health care insurance schemes do not have a good redistribution effect of allowing care resources to be distributed according to need (Zhu and Österle, 2019; Yang et al., 2020). There has not been a national comprehensive LTCI system in China; instead, different pilot cities have launched their individual LTCI pilots that vary in program design. Differences include target population, level of reimbursement, and covered services. These differences have led to growing concerns about inequalities in access to formal LTC services across different socioeconomic groups. In particular, some cities' LTCI only covers urban employees, but older people with lower income are more concentrated in rural residents, or urban residents without formal employment, making them less likely to be eligible for LTCI (Zhu and Österle, 2019). Even in some pilots, these two groups are taken into account, they are not always informed of their eligibility for enrolment in LTCI system or their entitlements to funded services. Some of the most vulnerable patients, such as rural residents with severe functional limitations but lower income, are rejected by care providers (Yang et al., 2020). Besides, co-payment rates and covered services significantly differ by health care insurance status. For example, the co-payment rates are set at 10% for older people who are urban employees, while the rates are around 60% for older people who are rural residents in Qingdao. Over 90% of home visit services users are urban employees, while these services are not available for rural residents in that city (Zhu and Österle, 2019). As a result, studies find that there is a significant degree of inequities in using formal LTC. Most service users at nursing homes and community day

care centres are those with formal employment in urban areas, while these services continue to be unaffordable for many low-income individuals (Du et al., 2021).

Studies show that although 95% of older people are enrolled in SHI schemes, large inequalities in health care utilisation between the rich and the poor remain as a result of the differences in these three separate schemes (Yang and Wu, 2015; Zhang et al., 2015). In terms of the choice of hospital types, Xian et al. (2019) find that UEMI participants are more willing to receive hospitalisation treatment in tertiary hospitals, while those who receive hospitalisation treatment in first-level hospitals are more likely to be enrolled in URMI. In terms of the types of hospital services, Tan et al. (2018) show that UEMI participants have higher outpatient visit rates in all hospital types than URMI participants, while URMI participants are less likely to use outpatient visit services, probably because URMI participants are unable to get compensation from the insurance scheme and can only use their own money for some outpatient care services. In terms of cost burden, Du et al. (2017) suggest that UEMI participants have the highest compensation ratios and have a higher utilisation rate, while URMI participants and NRCMI participants, those who are relatively poor, enjoy lower reimbursement rates, and thus only go to hospital when they have serious illnesses.

In conclusion, although China has made progress in developing formal LTC and health care systems, it faces important inequalities in access to care. Compared with the high-income groups, low-income older people have fewer opportunities to use formal LTC services, largely owing to underdeveloped formal LTC services in poor areas as well as limited coverage by LTCI. They also have less access to health care services, mainly due to rudimentary health care services in counties and fewer benefit packages by SHI. Thus, low-income older people have more disadvantages in using formal LTC and health care services, compared to those with higher income.

2.4.4 Income-related inequalities in natural and social environment among older people

Studies show that the lower the income of older people, the worse the natural and social environment in which they live (Fan et al., 2019; Zheng et al., 2022). In particular, He et al. (2022) find that compared to the low-income groups, high-income groups are more likely to

live near green space (e.g., park, natural forest) or blue spaces (e.g., lake, river). Since a better natural environment makes it easier for community-dwelling older people to walk and participate in outdoor activities, high-income groups are more likely to have better health and quality of life (Huang et al., 2019; Zhang and Li, 2019). In addition, Yu et al. (2021) and Wang et al. (2017) find that while several metropolitan cities in China, such as Shanghai, have developed age-friendly cities and communities, it is difficult for poor rural counties to improve the built, social, and service environment for older people. Due to limited infrastructure and lack of support from the central government, low-income groups, who are more concentrated in rural and remote communities, face greater barriers to living in age-friendly environment. Zheng et al. (2022) further provide the evidence that the poor community-built environment has a greater negative effect on health among older people with lower income. Therefore, compared to those with higher income, low-income older people may have more disadvantages in their living environment, which may influence their need for informal care.

2.5 Conclusion

This chapter provides an overview of income-related inequalities in the receipt of informal care in China. The chapter shows that inequalities are the result of the complex combination of individual factors, family factors, societal factors, and environmental factors. Low-income older people are more likely to have poor health and engage in unhealthy behaviours, which means that they have greater need for care, compared with the higher-income groups. However, rapid socioeconomic development has lured many young people, both females and males, from poor families away from rural areas into large cities or other countries in search of employment opportunities. Due to long distances and less flexibility in time allocation decisions, a large number of older parents in poor families have been left behind in rural areas. The erosion of traditional values of filial piety has also put low-income older people with functional limitations at further disadvantages in receiving informal care. Since they are unable to care for grandchildren or leave adequate bequests, but have greater need for receiving daily care, their adult children have less incentive to provide care in exchange. The use of formal LTC and health care is another concern for low-income older people, because access to and affordability of these services is limited for them. Furthermore, they face more disadvantages in their natural, built, and social environment, which may be harmful to their

health, influencing their need for informal care. ‘Worse health-greater need-less availability of informal care and less affordability of formal LTC and health care-even worse health’, this vicious cycle among low-income older people may place them in further disadvantaged place in health. The following chapter provides the conceptual framework used to analyse income-related inequalities in informal care receipt and its influence on health and health care utilisation.

Chapter 3. Conceptual framework

3.1 Introduction

This chapter provides a detailed overview of the conceptual framework that guided the analysis. The first section discusses the concept of informal care. The second section critically examines the concept of inequality in health and care (Mackenbach, 2019). Following previous studies, the third section presents the stress-buffering model (Thoits, 2011) and the disablement process (Verbrugge and Jette, 1994; Verbrugge, 2020) to describe how receiving informal care affects health, and discusses the possibility of heterogeneous effects by income. Finally, based on the Grossman model of health demand (Grossman, 1972; Van Houtven and Norton, 2004), the final section provides a theoretical basis to interpret the empirical findings on the effect of informal care receipt on health care utilisation and the effects among different income groups.

3.2 Definition of informal care

Numerous studies have defined informal care as unpaid care provided to older people with functional limitations by a person with whom they have a social relationship, such as a spouse, parent, child, other relatives, neighbour, friend, or other non-kin (Van Groenou and Glaser, 2006; Van Groenou and Boer, 2016). It is predominantly provided by the spouse and adult children with no monetary compensation, and these unpaid informal carers often lack professional skills and training in care responsibilities (Triantafillou et al., 2010).

Informal care is divided into four major types based on the need it addresses: (1) Care in activities of daily living (ADL), such as dressing, bathing, and eating, which are considered crucial for independent living; the ability to perform basic daily activities significantly impacts an individual's quality of life, and failing to recognise these growing need may contribute to a cycle of physical and mental health decline (Tennstedt and Mckinlay, 1994). (2) Care in instrumental activities of daily living (IADLs), such as cleaning the floor, laundry, and shopping; IADLs build on the basic activities (Mitra et al., 2011). (3) Financial support; it has become a common form of support for older people as adult children transfer remittances to parents to improve their economic well-being and purchase necessary services from the market. (4) Emotional support, including frequent contact and advice for decision-making; research suggests that speaking to family members helps relieve impatience and

anxiety by providing a sense of security and safety (Du et al., 2016; Verbakel et al., 2017). Researchers consider different types of care based on various aims. Many studies in China do not distinguish between these different types of care (An, 2019; Wang and Gao, 2011; Wang and Li, 2011), limited studies focus solely on care in daily activities.

This thesis defines informal care as unpaid care provided to older people with ADL limitations by a person with whom they have a social relationship, including spouse, parent, child, other relatives, neighbour, friend, or other non-kin. The care includes assistance in eating, dressing, bathing, getting in and out of bed, indoor transferring, and toileting. This thesis focuses on ADLs rather than other activities because ADLs are the most essential daily activities that other activities build on to enable independent living. The abovementioned definition has been frequently used in many studies and large-scale social surveys such as the China Longitudinal Ageing Social Survey (Hu and Ma, 2018; Suanet et al., 2012). This is also the definition used to collect information on informal care by the CLHLS—the dataset to be used in this thesis.

Informal care is the primary source of LTC worldwide. For example, in Europe, where the LTC system is well-established, over 80% is provided by informal carers (Verbakel et al., 2017; Zigante, 2018). The same phenomenon is also observed in Asian countries. For example, informal care accounts for approximately 24%–41% of LTC in Japan, where traditional filial piety imposes the main responsibility of care on families (Jang et al., 2012). The proportion of informal care in LTC is around 90% in China, where formal care is underdeveloped (Hu, 2019).

3.3 Income-related inequalities in informal care

As this thesis aims to study income-related inequalities in informal care, it is important to first define the theoretical framework used to conceptualise inequality.

Health, a highly-desired good, is unequally distributed across subgroups of the population according to multiple characteristics, such as demographic and socioeconomic characteristics (Mackenbach, 2019). For example, studies suggest that in several countries, people from different socioeconomic statuses or age groups differ in the number of ADL limitations (Fleurbaey and Schokkaert, 2009). The term ‘health inequality’ is used to refer to these

systematic differences. Inequalities may be perceived as legitimate and ethically acceptable or as illegitimate, unfair, and thus ethically unacceptable by society (Whitehead, 1992). According to the widely-used criteria developed by Whitehead (1992), legitimate variations are those that are attributed to causes that are potentially unavoidable and commonly considered fair, such as natural biological variation. Illegitimate inequalities, by contrast, are systematic differences based on socioeconomic factors that society judges as potentially avoidable and commonly considered unfair. Based on different socioeconomic status in society, people are assigned different levels of control over resources, such as money, power, or prestige, which may influence health behaviours, living and working conditions, and access to essential health and other public services. These variations are considered results of human actions and not natural phenomena.

However, this framework has some limitations. Its legitimacy is determined based on criteria such as 'potentially avoidable' and 'commonly considered unfair' (Whitehead, 1992), which are ambiguous and exceedingly emphasise whether health inequalities can be reduced by human action. Using this criterion as the first filter before assessing the unfairness of health inequalities is risky (Mackenbach, 2019). Additionally, this framework does not explicitly consider whether inequalities in health are generated by social inequalities. Braveman (2006), considering health inequalities from a broader perspective, proposed 'health inequity' to refer to systematic inequalities in health between social groups with different levels of social advantages and disadvantages. This implies that health inequalities are inequitable if they are systematically associated with social disadvantages such that an already-disadvantaged social group is further disadvantaged (Braveman and Gruskin, 2003).

There are several different ideological perspectives on inequalities in health and health care. Libertarians believe that all individuals are entitled to their possessions—as long as they were obtained legally through earnings, inheritance, or other means—and that any attempt by the government to redistribute wealth is an injustice (Nozick, 1974). They accept health inequalities as inevitable consequences to be suffered for the greater good. This argument is then applied to health care. Libertarians argue that individuals should be able to use their money and other resources to obtain more or better health care, government involvement in securing health care resources and ensuring health care access should be limited (Gutmann, 1981; Polivka, 2021).

On the contrary, egalitarians attempt to achieve equal opportunities or conditions. Egalitarianism refers to a broad family of theories of justice which differ in what they would like to see equalised, and philosophers are not in agreement on the optimal theory of justice (Arneson, 2013). The concept of the equality of resources, proposed by John Rawls (1971), focuses on inequalities in the distribution of resources by stipulating that socioeconomic inequalities are permitted only to the extent that they predominantly benefit the socioeconomically disadvantaged group. Daniels (2001) extends this theory to inequalities in health and health care. He argues that we are obligated to shift the resources from the rich to the poor to provide equal access to health care and eliminate the social determinants underlying health inequalities. The concept of the equality of capabilities, developed by Nussbaum (2011), stresses the importance of securing a threshold level of core capabilities, such as good health. Since everyone has the same right to lead a healthy life, reducing some people's capabilities to be healthy is unfair. The equality of welfare theory explicitly chooses equality of welfare as the justice and goal of public policy, for example, the equality in meeting an individual's health need (Dworkin, 2018).

Studies have demonstrated that policymakers are more likely to favour the egalitarian approach in equity of health and health care (O'Donnell et al., 2007; Poel et al., 2011). 'Equal access for equal need' is commonly used as the definition of equity of health care in the literature (Allin et al., 2011; Yang, 2013). Horizontal inequity rests on the assumption that individuals with similar need should receive the same level of care services regardless of their income or other socioeconomic conditions (Rodrigues et al., 2014). It refers to differences in use of care services across different socioeconomic groups that persist after differences in need have been taken into consideration. Several European health care systems are based on the notion that everyone in society has equal access to standard health care and that health care should be funded and allocated based on need rather than the ability to pay (Oliver and Mossialos, 2004). Particularly, socioeconomically disadvantaged groups tend to suffer worse health, and inequitable inequalities arise when they are unable to afford high health care costs and even give up treatment before they recover (Fleurbaey and Schokkaert, 2009). In Europe, policymakers are working to eliminate unfair health care inequalities by socioeconomic status, with a particular emphasis on improving conditions for those who have greater need but fewer opportunities (Stronks et al., 2016).

Compared to the number of studies on health care inequalities, those on inequalities in the access to LTC services, including formal and informal care, are limited. This could be because many countries have not yet implemented fully comprehensive a national LTC system. In traditional Chinese society, which is influenced by filial piety, older parents often rely on family members for LTC. There appear to be few differences in informal care receipt among older people (Hu and Ma, 2018). However, several transformations have occurred during the process of demographic transition and modernisation in recent decades. As mentioned in Chapter 2, the number of potential informal carers is decreasing, adult children from poor families, most of whom live in rural and underdeveloped areas, migrate to metropolitan cities, leaving their older parents behind, thus restricting access to informal care. Meanwhile, adult children's strong sense of obligation to provide care is reducing. Although older parents do not need to directly pay for the care provided by adult children, receiving informal care is based on exchange and is not completely free for older people. Therefore, older people with different socioeconomic statuses may experience different kinds of care at both the extensive (the probability of receiving care) and intensive (the amount of care received) margins. Research has suggested that low-income older people with functional limitations face more barriers in accessing informal care (An, 2019; Liu, 2015). For example, older people from lower socioeconomic groups face a higher probability of being left behind in poor areas and leaving fewer bequests to their children than higher socioeconomic groups (Cook and Dong, 2011). In other words, the distribution of informal care may be based not only on older people's need but also on their socioeconomic status.

Socioeconomic status is commonly measured by income or wealth, education, and occupation (Psaki et al., 2014). According to the definition of informal care, this thesis focuses on people who need care, i.e., older people with functional limitations. According to Zhang and Feldman (2020), these older people are generally the middle-old or oldest-old in China. As most of them are illiterate farmers, it is more appropriate to use income or wealth as the indicator of socioeconomic status rather than education or occupation (Du and Wang, 2017). Since current national datasets about the middle-old or oldest-old have scarce information on wealth, this thesis chooses income of older people as a measurement indicator to explore the inequalities in the receipt of informal care and examine its distribution among older people. Based on available information in the survey, the thesis uses household per capita income of older people as the key indicator of socioeconomic status, which will be introduced in detail in Section 5.3 of Chapter 5.

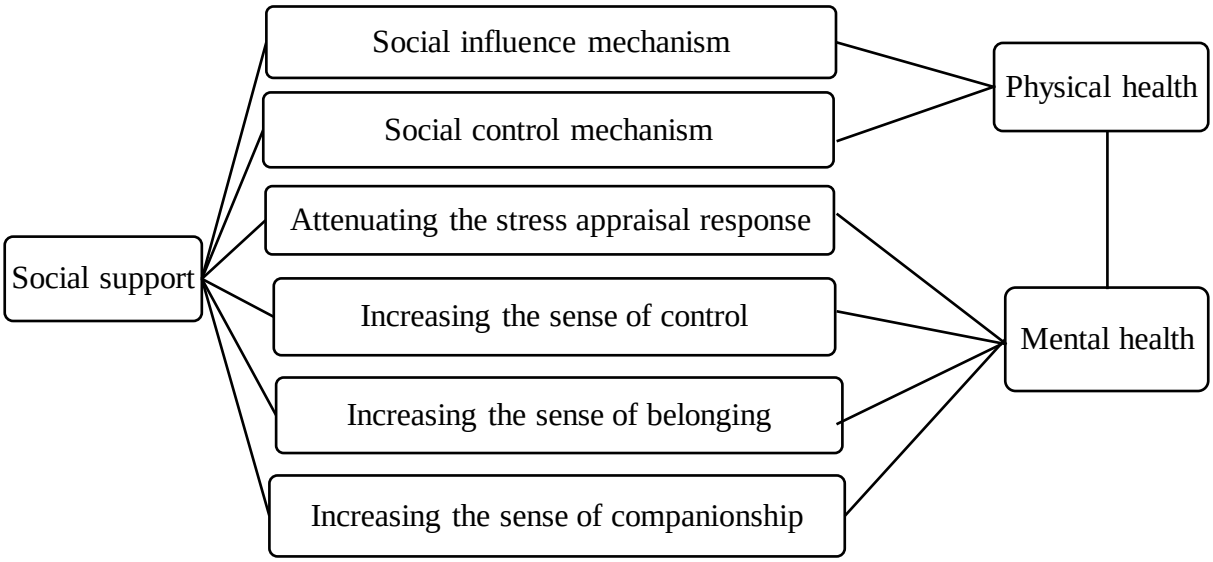
3.4 Effects of informal care receipt on health of older people

Low-income groups are less likely to receive informal care, which may translate into worsening health status and increasing income-related inequalities in health. This thesis seeks to understand the effect of informal care receipt (referred to as social support) on health status among older people from different income groups.

Social support is defined as the social resources that persons perceive to be available or that are actually provided to them by non-professionals in the context of both formal support groups and informal helping relationships (Gottlieb & Bergen, 2010). It is a multifaceted concept, with four commonly used measurement: (1) network contact frequency, (2) satisfaction with support, (3) perceived availability of support, and (4) use of support (Fiore et al., 1986). There are a wide range of types of social support, including emotional, instrumental, companionship, informational, and esteem support. Based on the definition of informal care, this thesis focuses on instrumental support, uses the receipt of informal care to measure social support, and examines the effect of receiving informal care in daily activities on health from the perspective of social support.

Numerous studies have been conducted to investigate the mechanisms through which social support influences physical and mental health; the stress-buffering model has received the most attention (Cohen and Wills, 1994; Suanet et al., 2020; Thoits, 2011). It posits that stress arises when an individual appraises a situation as threatening or otherwise demanding and does not have an appropriate coping response; in these situations, while the individual perceives that responding is important, an appropriate response is not immediately available. Such experiences are presumed to put the individual at risk of physical and mental impacts. Therefore, according to the stress-buffering model, receiving social support in response to need is expected to increase coping strategies, reduce stress assessments, and protect against negative health impacts. In the following sections, we discuss how social support improves both physical and mental health through various pathways, which is shown in Figure 6.

Figure 6. The stress-buffering model



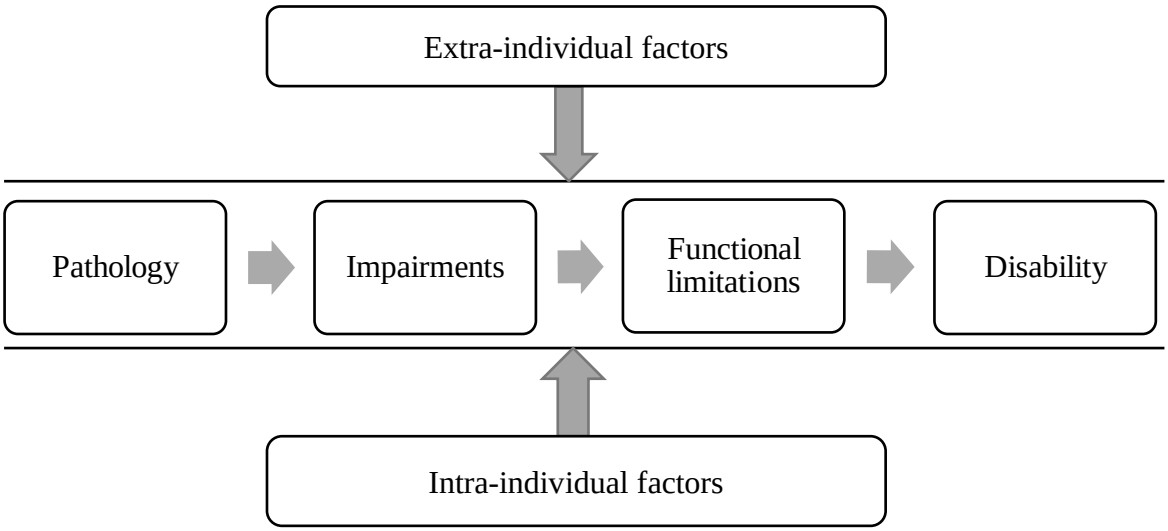
3.4.1 Effects of informal care receipt on physical health of older people

Suanet et al. (2020) propose that the stress-buffering effect of social support on physical health outcomes occurs through social influence and social control mechanisms. Berkman et al. (2000) argue that the health attitudes or behaviours of carers act as information that influences care recipients, and such influence occurs through simple observation and contrasting themselves with others while receiving care, rather than engaging in explicit discussion or persuasion. Toyoshima and Nakahara (2021) further opine that carers need not deliberately or consciously attempt to change care recipients' behaviours because care recipients tend to change their behaviours spontaneously and deliberately. In particular, older people assess the appropriateness of their attitudes, beliefs, and behaviours against standards that are avowed and modelled by carers, usually shifting their own to match those of the carers. According to this mechanism, studies indicate that by spontaneously imitating carers' health behaviours, older people acquire more useful information, such as the appropriateness of smoking and drinking, attending to diets, and taking medication on time (Robinson and Rintala, 2003). However, Thoits (2011) point out that some carers may provide inaccurate information, such as unhealthy diets and lifestyles, and older people may model these risky behaviours, thus exposing them to more stressful events.

Social control is a more active and direct mechanism (Uchino, 2004b; Umberson, 1987), which refers to the explicit attempts of carers to persuade care recipients to adopt or adhere to positive health practices (Umberson and Montez, 2010). For example, carers may regulate health behaviours that affect older people's health, such as controlling the type and amount of food available to older parents, especially when they have a weight problem or a nutrition-based health problem (Zigante, 2018). Thoits (2011) highlights that social control efforts discourage risky health behaviours to reduce stress but may backfire if they are perceived as overly intrusive or dominating, consequently creating resentment and resistance to behavioural changes. Studies have shown that some family members impose healthy lifestyles on older people in an unscientific or rude manner, thus increasing their stress levels and resulting in poorer health (Wang and Gao, 2011). Hence, like the social influence mechanism, the social control mechanism can be beneficial or harmful depending on the strategies carers employ to regulate older people's behaviours.

The disablement process, proposed by Verbrugge and Jette (1994), is consistent with the idea that social support has a protective effect on health. As shown in Figure 7, this model posits a pathway to focus on people's functional situation over time from pathology to body system impairments, functional limitations, and disabilities. Each concept is distinct and has been defined in previous studies (Lawrence and Jette, 1996; Peek et al., 2005; Verbrugge, 2020; Zhang, 2017): Pathology refers to the biochemical and physiological abnormalities that are detected and medically labelled as disease or injury. It has an immediate or delayed impact on impairments, which are defined as functional and structural abnormalities in specific body systems. Verbrugge (2016) state that such impairments influence the individual's ability to perform daily activities. Functional limitations are defined as restrictions in an individual's ability to perform basic physical actions in daily life, such as reaching up and walking. Verbrugge (2020), focusing on individuals and their environment, argue that a functional limitation is an individual ability without reference to requirements in the physical and social environments; if the environment requires the ability to complete particular actions, a functional limitation may result in a disability. Therefore, disability is an expression of a functional limitation in a social environment. It is defined as the gap between expectations to perform specific activities and ability to fulfil those expectations; that is, the difficulty in acting in an expected ways in the society (Lowry, 2010; Verbrugge, 2020).

Figure 7. The disablement process model



Verbrugge (2020) report that the level and pace of the disablement process are influenced by both intra- and extra-individual factors. Intra-individual factors are features within individuals to enhance their functional ability, such as positive changes towards healthy lifestyles and behaviours. Extra-individual factors are features outside the person to help them slow down the decline in functional ability, such as medical care and external support. Following this model, informal care, as a type of extra-individual factor, aims to protect against potential disability, help older people maintain and restore functional capacity, and maximise their independence and social involvement (Jette, 2009). With assistance in conducting basic daily activities, older people are expected to better manage their health and functional ability.

However, there is a paucity of empirical research testing these theories. Most research findings come from European countries or the US, and vary according to the methods used, groups of people under investigation, and sociocultural context. There is few evidences demonstrating the effect of receiving informal care on older people's functional ability in China.

3.4.2 Effects of informal care receipt on mental health of older people

Thoits (2011) proposes that social support protects against mental health problems. Cohen and Pressman (2004) state that social support may intervene between the stressful event and

stress reaction by attenuating or preventing a stress appraisal response. Specifically, Uchino (2009) reasons that the inability of an individual to perform daily activities without help is often appraised as a highly stressful event. Those who receive social support believe that others can and will provide necessary assistance to help them complete daily tasks, which may redefine the potential harm posed by functional limitations, bolster their perceived ability to cope with daily activities, and prevent the situation from being assessed as highly stressful. Based on this pathway, Kwag et al. (2011) verify that greater support from family members in daily activities lowers older people's stress levels and thus results in fewer depressive symptoms.

Another pathway between social support and mental health is a sense of control, which refers to an individual's belief that they have control over their lives, with few perceived constraints (Pearlin and Schooler, 1978). Older people with functional limitations reportedly experience reductions in perceived control because they are more likely to encounter difficulties in performing basic activities (Yang, 2006). Receiving social support ensures that older people with functional limitations have enough resources to cope with stressful events, thereby increasing their sense of control (Zhou and Yao, 2020). Pilcher et al. (2016) report that improving an individual's sense of control decreases helplessness in the face of adversity and mitigates depressive symptoms. This mechanism is supported by Lai et al. (2019) and Schulz and Eden (2016), who provide evidence that social support—by improving individuals' sense of control—reduces depressive symptoms and improves subjective well-being.

A sense of belonging and companionship is another mechanism that links social support to mental health (Cohen and Wills, 1994). 'Belonging' refers to acceptance and inclusion by others with whom individuals are emotionally attached and whom they view as important or influential in their lives (Cobb, 1976). Uchino (2004a) state that companionship, a close corollary of acceptance and inclusion, is defined as having others with whom one can share social activities. According to Choenarom et al. (2005) and Turner and McLaren (2011), social support fulfils an individual's need for affiliation and contact with others, provides the security that their need will be met by others, and provides a sense of belonging and companionship. Thomas et al. (2017) and Wakefield et al. (2017) report that a sense of belonging and companionship is linked to higher levels of life satisfaction and lower levels of depressive symptoms. Meanwhile, increasing the sense of companionship leads to the

reduction of loneliness, which is also associated with lower levels of depression and anxiety (Cacioppo et al., 2010). Thoits (2011) find that social support influences mental health by providing a sense of belonging and companionship and reducing loneliness.

However, some studies have suggested that social support may have negative consequences (Reinhardt et al., 2006). Lin and Wu (2011) and Wolff and Agree (2004) find that older people may become aware of their lack of competence in daily life and overreliance on others by imagining their own performances through the others' perspectives, thus threatening their self-esteem (i.e., general beliefs about their goodness, worth, or competence) and eventually precipitating depression. Moreover, Kaschowitz and Brandt (2017) demonstrate that excessive care may overwhelm the positive effects of social support because carers become increasingly strained, which increases the frequency and intensity of negative interactions between carers and care recipients, thus causing increased disability and depressive symptoms.

Notably, research on these negative consequences has emphasised the importance of considering the sociocultural context. On a broad level, the distinction in sociocultural context is between more collective and individualistic cultures (Hu and Li, 2018). Lin and Wu (2011) state that people in most Western countries are influenced by a more individualistic culture, wherein the primary goal is to be relatively independent. Yang (2006) find that when older people receive informal care, they develop a stronger sense of dependence, which can have a negative influence on their health. In contrast, Uchino (2004a) state that older people in Asian countries may be more likely to view the self as part of a larger social whole, emphasising the self's interdependence with others. According to Hu and Li (2018), Chinese older people place greater emphasis on their role in the family than on their self-esteem. Specifically, the sense of belonging and companionship that comes from knowing that they are important to their family may be far greater than the depression caused by a loss of self-esteem. Thus, in comparison to Western countries, social values in China may provide additional buffering effects when receiving care from families.

Another factor worth consideration is the amount of social support received. Silverstein et al. (2006) highlight that the protective effect of social support may reach a limit if excessive care is provided. Particularly, studies have found that carers experience increasing strain by

executing caregiving responsibilities on a day-to-day basis (Vlachantoni et al., 2013). Such negative influence may affect the quality of social support, impair their relationship with care recipients, and increase discomfort and stress in the family (Hu and Li, 2018). Therefore, the effects of informal care receipt on health require further empirical investigation.

3.4.3 Heterogeneous effects of informal care on health by income

Zwar et al. (2019) place social support in a broader social context, hypothesising that the relationship between social support and health may differ depending on socioeconomic status. However, few empirical studies have examined socioeconomic differences in the effect of social support on health. According to the stress-buffering model, this section discusses how the effects of informal care receipt on health may differ by income—the key indicator of socioeconomic status on which this thesis focuses.

According to Thoits (2011), social influence mechanisms may have either protective or detrimental effects on health depending on the predominant health beliefs and behaviours of carers. In this thesis, it is assumed that family carers and care recipients share similar levels of socioeconomic status. Pampel et al. (2011) state that a socioeconomic gradient exists in health beliefs and behaviours. Socioeconomic status is closely related to key resources—such as knowledge, money, and privileged social relationships—that can be used to avoid risks or slow further decline in health. The different abilities of carers from various socioeconomic groups in possessing and utilising these resources result in a variety of coping abilities and strategies, which can be provided to older people. In particular, there is evidence that low-income groups have fewer health-promoting beliefs and behaviour (Mudd et al., 2021). For example, carers in low-income families are more likely to smoke or drink excessively but are less likely to buy healthy fresh foods (Kamphuis et al., 2019). Due to their influence, low-income older people may be exposed to fewer warnings about smoking, poor diet, and lack of exercise, and thus engage in such health-damaging behaviours. On the contrary, carers in high-income families exhibit more healthy behaviours and lifestyles, thus potentially influencing older people to do the same.

Like the social influence mechanism, social control effects can be beneficial or harmful, depending on the strategy employed by others to regulate people's behaviour (Thoits, 2011). Related studies have suggested that carers in low-income families face more stressful events

in their lives, such as unemployment and marginalisation; in such circumstances making time to provide care and regulate older people to appropriately adopt health-promoting behaviours are perceived as stressful events (Beach et al., 2005). Chen and Dong (2011) evince that such stressful situations are associated with some harmful caregiving behaviours, such as screaming and yelling, which lowers the quality of informal care in low-income families and mitigates benefits to older people's health. By contrast, An (2019) and Ji (2018) find that carers from high-income families possess more resources and coping strategies, face fewer stressful events, and thus remind older people to adopt healthy behaviours more gently and scientifically, thus enhancing the quality of informal care.

In general, older people with lower income are likely to experience more limitations in functional ability and more severe depressive symptoms, compared to those with higher income. Even if they receive the same amount and quality of care, their health improvement might not be noticeable. According to the stress-buffering model, receiving informal care may have protective effects by slowing down the decline in functional ability and fewer depressive symptoms. However, there might be income-related inequalities in the protective effects of informal care. Due to their carer's lack of knowledge about health and their behaviour-regulation strategies, low-income older people may be less likely to adopt healthy behaviours, resulting in a faster decline in health.

3.5 Effects of informal care receipt on health care utilisation of older people

Given their poorer health status, older people with lower income might be more likely to seek health care. However, informal care may affect the extent to which older people use health care and it may differ by income. This section discusses the link between informal care and health care utilisation based on an extension of the canonical Grossman model of health demand.

3.5.1 Extension of the classic Grossman model of health demand

Grossman (1972) stipulates that there are two reasons why individuals need healthy time: first, it allows for the enjoyment of good health (consumption benefits); second, it allows time to be spent on market and non-market activities (investment benefits). The central proposition of this model is that health is a type of durable capital that produces an output of healthy time. Individuals assumedly possess a certain level of health stock at birth, which

depreciates with age; however, they can invest in health to offset the depreciation (Grossman, 1972; Jager, 2017). In particular, health investments are generated by the production function and its inputs include individuals' time and market goods, such as health care.

Jacobson (2000) extends the Grossman model in that the family is seen as the producer of health, implying that each family member is responsible not only for their health but also for other members' health. In the classical model, individuals receive both investment and consumption benefits from investing in their health (Grossman, 1972). According to Jacobson (2000), this is also valid for investments in other family members' health. For example, investment benefits occur because improved family members' health reduces the amount of time spent caring for a sick person. Family time available for market work will thus increase, potentially increasing family income and expanding consumption and investment opportunities for all family members.

Van Houtven and Norton (2004) further extend this classic model by incorporating informal caregiving to focus on the older adults' choice of health care and how it is influenced by the informal care they receive. In this model, care demands among older adults and those among the general population depend on similar factors, such as physical ability, cognitive function, and socioeconomic status. The receipt of informal care may be another important determinant of health care demand for older adults because it might reduce or increase the utilisation of health care by influencing older adults' health. In particular, children generally consider their parents' health status when their parents cannot perform daily activities on their own. They often decide whether to provide informal care and determine the optimal amount of informal care to provide to maximise the benefits for the whole family. In these circumstances, older adults may decide to use health care based on the amount of informal care they receive to meet their health demands.

Following this conceptual framework, informal care receipt may reduce or increase health care utilisation, and the impact differs depending on the type of health care (Bonsang, 2009; Van Houtven and Norton, 2004). Specifically, informal carers often provide low-skilled care to older people, their health demands are partly satisfied, resulting in less probability of seeking some outpatient care services. For example, assistance in bathing and indoor transferring prevents older adults from being burned/scalded or accidental falls; assistance in feeding or preparing meals helps them have a healthier diet and sufficient nutrition; and

regular monitoring in taking medication helps them better control disease exacerbations. These positive influences have a feedback effect on their health conditions by protecting them against health decline, and consequently reducing outpatient care utilisation (Van Houtven and Norton, 2004).

However, informal care could not reduce the use of some inpatient care that requires higher level skills and more advanced procedures, such as complex surgeries. Because informal carers often lack professional skills, when older people require highly qualified and specialised health care, low-skilled informal care is unable to meet older people's need, and professional care is required in some cases. Torbica et al. (2015) provide the evidence that informal carers act as agents of older people, they are likely to notice the need for high-skilled care and facilitate the occurrence of high-skilled care by setting up an appointment and providing transportation. Bolin et al. (2008) find that having an informal carer as an advocate may improve the quality of care and help older people have a comprehensive physical examination, thus increasing the length of hospital stay. Informal carers could help identify errors in medication administration or notify the medical staff more quickly in case of adverse circumstances. However, there is few empirical studies in China to examine whether informal care receipt reduces or increases health care.

3.5.2 Heterogeneous effects of informal care receipt on health care utilisation by income

Grossman (1972) suggest that the effects of informal care receipt on health care utilisation are not uniform across different subpopulations. However, few theoretical models have provided evidence of this and examined differences in individuals' health-related behaviour (e.g., why different individuals exhibit different health care utilisation). This thesis aims to investigate the various effects of informal care receipt on health care utilisation among older people from various income groups.

To understand why the effects of informal care may not be uniform for all older people, it is useful to return to the pivotal point of this conceptual framework—health demand. In general, older people with lower income are more likely to have poorer health status than those with higher income and thus have a higher baseline risk of needing health care. If higher income people are more likely to receive informal care and the positive health effects of informal

care are stronger, there will be a lower level of health demand relative to those with lower income. In other words, for those with higher income, receiving informal care may reduce the impairment rates, hospital admission rates, length of hospital stays, and consequently health care expenditure to a larger extent than for those with lower income. To satisfy unmet health need, those with a lower income may seek health care more often than those with a higher income. Thus, receiving informal care may increase the likelihood of using health care among low-income groups more than among high-income groups.

3.6 Conclusion

This chapter reviews relevant theories and conceptual frameworks for this thesis's empirical analysis. Drawing from relevant studies, the definition of informal care is first introduced. Based on previous literature on inequality (Braveman, 2006; Mackenbach, 2019; Whitehead, 1992), I discuss the concepts of inequality (in health, health care and informal care) while focusing on potentially avoidable inequality, which is commonly considered unfair, such as socioeconomic inequalities; thereafter, I introduce different ideological perspectives on inequalities in health and health care. Following numerous studies, I take the egalitarian approach and use income as the indicator of socioeconomic status to investigate income-related inequalities in informal care receipt in this thesis. Subsequently, I introduce the stress-buffering model (Thoits, 2011) and the disablement process (Verbrugge and Jette, 1994; Verbrugge, 2020), and discuss the different mechanisms that link informal care to health to consider the heterogeneous effect of informal care on health by income. Finally, I review the Grossman model of health demand (Grossman, 1972; Van Houtven and Norton, 2004), and discuss how the effect of informal care on health care utilisation may differ across income groups. In the next chapter, I review current evidence on income-related inequalities in informal care receipt and on the effects of informal care receipt on older people's health and health care utilisation.

Chapter 4. Literature review

4.1 Introduction

This chapter provides a scoping review of the existing literature on socioeconomic inequalities in LTC utilisation, the effect of receiving informal care on health, and the effect of receiving informal care on health care utilisation in the US, European countries, China, and other Asian countries. The first section outlines findings on the distribution of informal and formal care utilisation across different subpopulations, such as those with different races, income, and education levels. It summarises the methods used and highlights the limitations of current evidence. The second section provides a literature review summary on the effect of receiving informal care on physical and mental health and the diverse impact across different subpopulations, concluding with research gaps that the current research presented in this thesis addresses. The third section reviews the literature on the effect of receiving informal care on health care utilisation and the diverse effect across different subpopulations. The final section discusses why China provides an interesting context in which to explore inequalities in informal care.

4.2 Socioeconomic inequalities in LTC utilisation

It is well known that the population is ageing at a rapid pace and the oldest-old population is growing at a faster rate than any other age group in many countries (WHO, 2015). With the population living longer and having greater care need due to increased morbidity, it becomes necessary to understand the demand and supply of LTC. Improving our understanding of the differences in the demand for LTC is important not only because the population is ageing but also because the ageing population is becoming increasingly diverse. The main objective of the WHO LTC series is to develop sustainable and equitable LTC systems (WHO, 2015).

4.2.1 Review of studies in Western countries

Socioeconomic conditions differ in different countries and regions. Many studies in the US have focused on racial and ethnic inequalities in LTC use, such as inequalities between Blacks and Whites (Konetzka and Werner, 2009). In general, some studies suggest that Blacks have less access to nursing home care than Whites despite their poorer health status. Morrow-Howell and Proctor (1994) and Wallace et al. (1998) use data on 369 older people discharged from one hospital in Midwest in 1988–1989 and the National Medical

Expenditure Survey in 1987, respectively, and performed multinomial logit regression analysis and conclude that Blacks are half as likely as Whites to use a nursing home after adjusting for risk factors. They explain that racial discrimination is an important factor in the admission of Blacks to nursing homes. Researchers investigate whether these inequalities persist over a long period. Based on National Nursing Home Surveys in 1977–1999, Ness et al. (2004) calculate rates of nursing home use per 1,000 older people and find that the racial gap is decreasing, with a decrease in rates of nursing home use for Whites but an increase for Blacks. However, this descriptive method does not account for need-related or other socioeconomic factors, making it impossible to demonstrate horizontal inequity caused solely by racial factors. Drawing longitudinal data from the Survey of Assets and Health Dynamics Among the Oldest Old cohort, Akamigbo and Wolinsky (2007) use hazard models to show that the racial gap in nursing home replacement remains over the 11-year period but is narrowing. One possible explanation for this change is the increased availability of nursing home beds and facilities in Black communities and the substitution of formal home care for nursing homes among Whites. However, other studies report contradictory results. White-Means and Rubin (2004) and Webster et al. (2004) find that after controlling for need-related and other socioeconomic factors, Blacks are less likely to use nursing home care but more likely to use formal home care than Whites.

Instead of focusing on racial and ethnic inequalities, studies in European countries pay more attention to older people's education levels, income, and between-country differences in LTC utilisation. Educational level is considered an indicator of socioeconomic status and may also capture cognitive resources and skills that are useful in enhancing individuals' ability to choose care services (Van Broese Groenou and Van Tilburg, 2003). Studies suggest that higher education translates into more supportive non-kin support in older age. Using data from the Survey of Health, Ageing, and Retirement in Europe, Haberkern and Szydlik (2010) find that after controlling for individual characteristics, family structures, welfare state institutions, and cultural norms, the higher the educational level, the higher the probability of accessing formal home care services and the lower the probability of receiving informal care in 11 European countries. Using concentration indices, García-gómez et al. (2015) and Lera et al. (2021) discover the same pattern for Spain. They argue that better educated people are more aware of their rights and entitlements to formal care, better able to assert them, and more likely to be able to afford the high cost of formal care. However, using population-averaged logit models, Albertini and Pavolini (2017) find that an individual's educational

level plays a limited role in LTC utilisation in Germany and France. They argue that micro-level social mechanisms regulating access to LTC vary across countries, and the role of socioeconomic factors should be considered separately for each country.

Income captures financial resources and influences individuals' ability to purchase formal care (Rodrigues et al., 2018). There are two common methods for investigating income gradients in LTC use: logistic models and concentration indices. Most studies have shown a pro-rich distribution of formal care. Based on nationally representative cross-sectional data in Finland, Blomgren et al. (2008) use logistic regression models to identify a positive relationship between higher income and greater use of formal care services in a well-developed welfare state. Based on data from the fourth wave of the English Longitudinal Study of Ageing, Vlachantoni et al. (2015) use logistic regression models and find a positive association between income and formal care use in England. Drawing longitudinal data from the Survey of Health, Ageing, and Retirement in Europe, Albertini and Pavolini (2017) use population-averaged logit models and find a positive relationship between income and formal care use in Germany and Italy. Furthermore, concentration indices, the most commonly employed indicators of inequalities and inequities, have been used in previous studies to support these findings. Many studies have measured the level of horizontal inequity in the use of LTC services. Bakx et al. (2009) find that there is inequitable distribution of the use of LTC services in Germany, and formal community services are more concentrated among the better-off. After adjusting for need-related factors, García-gómez et al. (2015) and Rodrigues et al. (2018) find pro-rich inequality in formal domestic help in Spain and Italy. Vincenzo et al. (2017) conclude that pro-rich inequality is more pronounced in countries where public financing for LTC is relatively low. With the availability of public home care services and allocations primarily based on means, pro-rich inequity has decreased.

However, there are inconsistent findings on the distribution of informal care receipt based on income. Some researchers have found a pro-poor distribution of informal care receipt. Using the horizontal inequity index, García-gómez et al. (2015) provide evidence that after controlling for a wide set of need-related factors, intensive informal care is concentrated among the worst-off in Spain. Using the same method, Rodrigues et al. (2014) find a pro-poor inequity in the use of informal care in most European countries, regardless of the development of public financing for LTC. A possible explanation for this may be that low-income family carers have lower opportunity costs to leave lower-paying jobs and a stronger

desire to limit out-of-pocket spending (Vincenzo et al., 2017). Consequently, they may be more likely to provide informal care. On the contrary, Groenou and Glaser (2006) use a multinomial logistic model and find that older people with higher income receive more informal care in the Netherlands. Moreover, using a representative sample of Spanish dependent older people from the Disabilities, Independence, and Dependency Situations Survey in 2008, Rodríguez (2014) use the same method to compare the factors associated with the use of informal, formal, and mixed care (informal and formal care together). The results show that the higher the income, the higher the likelihood of receiving only informal care. Drawing data from the last wave of the Survey of Health, Ageing, and Retirement in Europe, Lera et al. (2021) calculate the horizontal inequity index to assess the distribution of informal care. They found a pro-rich distribution of informal care receipt. After considering care need, informal care is concentrated among high-income groups in European countries.

These conflicting findings could be partly explained by differences in the need-related factors used. Need is the most important factor in determining LTC utilisation, and the aforementioned studies used a variety of indicators to assess need. Some studies only considered functional limitations while ignoring other factors, such as self-rated health, chronic diseases, and cognitive impairment. After controlling for functional limitations, the results may still reflect inequalities driven by need rather than solely by socioeconomic factors, resulting in potential bias.

Other scholars explain that socioeconomic inequalities in care utilisation vary by country depending on the share of public coverage and the social values of family ties. Based on cross-sectional data, Vincenzo et al. (2017) classify European countries into northern Europe, continental Europe, and southern Europe based on differences in public coverage and cultural values. They calculate concentration indices and find that there are greater pro-poor inequalities in the use of informal care in southern Europe, where there is a low level of public financing of LTC and a high degree of responsibility on the extended family for providing LTC services, whereas they did not detect significant income-related inequalities in northern Europe, where there is a high level of public financing of LTC and individual responsibility in the provision of LTC services. Furthermore, Floridi et al. (2020) use the degree to which the state or the market takes responsibility for care provision as an indicator to identify the difference in income-related inequalities in different European countries. In particular, LTC systems characterised by de-familisation offer alternatives to informal care,

thereby reducing family responsibility, while LTC systems characterised by familism refer to settings in which policies, cultural norms, and preferences emphasise the family as the sole or main provider of care. Based on multinomial multilevel models in a cross-sectional design, they find that higher de-familisation may alleviate income-related inequalities in LTC by providing alternatives to family care among low-income groups, while higher familism may lead to exclusive reliance on informal care, especially among low-income individuals who may be unable to afford alternatives to family care. However, the cross-sectional design only compares care utilisation at a single point in time and does not investigate inequalities over time. In addition, some countries are not represented in the data, therefore, these findings may not apply to all countries, and an empirical analysis for each country is required.

4.2.2 Review of studies in Asian countries

Compared to numerous studies examining socioeconomic inequalities in LTC use in Western countries, relevant studies are scarce in Asian countries, where informal care accounts for a large portion of care for older people. Influenced by traditional culture, Asian countries are typically regarded as traditional Confucian societies. This is reflected in the low level of investment in LTC infrastructure (e.g. formal LTC services and family caregiver support systems, including carer allowance, policies governing compatibility of caregiving with work), inadequate social security safety nets (e.g. insurance systems that enable older people to live independent of their adult children), or the cultural stigma associated with having one's parents or spouse cared for by strangers (Jang and Kawachi, 2019).

Although Japan has implemented a public, mandatory, and universal LTC system since 2000, traditional familism continues to influence family caregiving (Saito et al., 2018). Using semi-structured interviews, Izuhara (2003) find that a lower income translates to a higher probability of relying on family support. Based on a nationwide survey conducted by the Japan Gerontological Evaluation Study in 2013, Saito et al. (2018) use a Poisson regression model to support this finding, showing that caregivers in low-income groups are more likely to engage in family caregiving than those in high-income groups. In contrast, Jang and Kawachi (2019) use generalised linear models and find different results in a cross-sectional study in Korea, demonstrating that low-income older people are less likely to receive informal care than those with higher income. These cross-sectional studies examine the population at a single point in time, thus limiting the representativeness of the results.

Furthermore, they fail to consider some of the factors that influence informal care receipt, such as monetary transfers within the family, which may influence older people's decisions and care preferences.

In China, 92% of older people receive care from their spouses and children (Du et al., 2016). The proportion of informal care is significantly higher, whereas formal care is still in the initial stage of development. Therefore, studies on inequalities in LTC use in China are relatively scarce. Peng et al. (2017) calculate the proportion of informal care and find that income has a U-shaped relationship with LTC use. Older people in the middle-income group are more likely to receive informal care than those in the lower- and higher-income groups. However, they do not consider need-related or other socioeconomic factors, which could lead to bias. After controlling for these factors, Du and Wang (2017) use logistic regression models in a cross-sectional study and find that formal care utilisation is more concentrated among high-income groups, whereas informal care use is more concentrated among low-income groups.

On the contrary, An (2019) argue that during the process of modernisation, traditional parental power has challenged and exchange motivation in intergenerational relationships has increased. Adult children are more likely to provide more support to older parents with a higher socioeconomic status in anticipation of future transfers, including bequests. She provides empirical evidence that high-income older people are more likely to receive care in daily life from adult children. As this cross-sectional study did not account for time effects, the findings may not be applicable to the population in other years. Using a longitudinal dataset, Liu and Tang (2020) find evidence that income is positively associated with more hours of care received from family members. They explain that income inequality results in significant differences in informal care resources among older people. Carers in low-income families have a strong overlapping relationship between work and caregiving. They have less flexibility in time allocation decisions and higher opportunity costs to provide care, leading to less participation in informal care. However, this study does not consider some factors that influence the receipt of informal care, such as functional limitations, availability of formal care, and monetary transfers from adult children. In addition, Hu and Ma (2018) and Wu et al. (2014) find that income does not significantly influence this distribution. Both studies had limitations, such as using cross-sectional or regional data and not controlling for confounding factors.

4.2.3 Research gap

The increasing demand for LTC services will pose a significant challenge to China's ageing society in the future. Although the government formally proposed ensuring formal care services for all as a basic principle for developing the LTC system, formal care services are either fragmented or non-existent in most parts of the country; thus, informal care will continue to be the predominant type of LTC in the coming years. Therefore, it is beneficial for China to assess socioeconomic inequalities in informal care receipt and ensure efficient utilisation of the limited resources by the government for providing formal care to individuals who receive less informal care. As a large number of older people are illiterate and unemployed in rural areas, it is more appropriate to use income rather than education or job to measure socioeconomic status (Du and Wang, 2017).

Several studies have used cross-sectional or regional data, which may not provide a comprehensive understanding of inequalities in informal care receipt. Longitudinal analysis, however, has the advantage of controlling for unobserved individual heterogeneity and trends over time during the past years. Thus, this thesis contributes to the limited literature using longitudinal data from a representative national survey.

The methodology used in studies in Western countries can be sorted into three categories: 1) descriptive analysis, such as constructing tables of means and quantiles, measures of dispersion, (e.g. variance or standard deviation), and cross-tabulations; 2) regression analysis, such as a multinomial regression model, longitudinal regression analysis, and probit model; and 3) concentration index. Most studies in China use the former two methods. Concentration index, advocated by Van Doorslaer (2009), has the advantage of quantifying income inequalities across different income groups. It provides a holistic assessment of inequalities instead of calculating the mean health for each income quintile, as is common in the first two types of analysis. Thus, this thesis narrows the research gap by using concentration index to quantify the magnitude and direction of income-related inequalities in informal care receipt.

4.3 Effect of informal care receipt on health of older people

Informal care is essential for older people who have become physically frail and consequently have difficulty with or are unable to perform daily activities by themselves. Numerous studies have shown that health is the most important determinant of informal care receipt. Increased hours of informal care are provided to older people with functional limitations (Bonsang, 2009; Hu and Ma, 2018). In comparison, little is known about the health effects of receiving informal care. The goal of informal care is to help older people stay at home by maintaining or improving their health; however, there is a paucity of empirical studies on the effect of informal care receipt on health of older people. It is important to investigate this to determine the extent to which informal care affects health over time. Furthermore, the effect of informal care on older people's health might differ according to income, which is a central question addressed in this thesis.

4.3.1 Review of studies in Western countries

Most empirical research on this topic comes from the US and European countries, and there is no consensus about the effects of informal care receipt on older people's health (Lindsay Smith et al., 2017). Using the chi-square test, Desai et al. (2001) find that a lack of informal care is associated with worse health conditions and the ability to maintain health. In contrast, Renata et al. (2012) use Spearman's correlation coefficients and found that receiving more care from family members is not significantly associated with functional ability. However, these descriptive methods only provide information about the correlation between informal care and health but do not test the causal effects of informal care on health.

Some cross-sectional studies use linear regression or logistic regression models to control for confounding factors. In terms of physical health, using hierarchical linear regression, Everard et al. (2000) find that receiving care in daily activities is associated with better functional health scores in a sample of 244 older people in the US. Furthermore, Moore (2019) find that stronger support from family in daily life is associated with better self-rated health in a sample of 790 older Irish migrants in London, after adjusting for demographic and socioeconomic factors. In terms of mental health, drawing data from a cross-sectional study of community-dwelling older people in a metropolitan area of Madrid, Zunzunegui et al. (2001) use multiple linear regression models and find that for widows who live alone, family support in daily activities is associated with fewer depressive symptoms, particularly in

cultures where family interdependence is valued. Using mediation analysis, Fiori et al. (2006) find that receiving care is associated with fewer depressive symptoms by developing the belief that one can meet daily life challenges in a sample of 719 older people in the US. Moreover, Golden et al. (2009) find that family support is associated with a lower prevalence of depression among community-dwelling older people in Dublin urban areas. Choia and Ha (2011) use data from the first wave of the National Social Life, Health, and Ageing Project to show that receiving support from spouses in daily life is associated with lower depression scores in later life. In contrast, based on data from the first wave of the Survey of Health, Ageing, and Retirement in Europe, Djundeva et al. (2015) use multivariate logistic regression models and find that receiving little or excessive care from children is associated with higher levels of depression.

These cross-sectional studies have some limitations, one of which is the sample size. Several studies have a small sample size or use regional data, which is insufficient to produce reliable results, and the results are not applicable to the entire country. The cross-sectional design is another limitation. It cannot be used to examine the effect of informal care on health over time. Moreover, it is difficult to establish a causal relationship between informal care and health, and the results due to the cross-sectional design may not be representative in subsequent years.

Using longitudinal data helps researchers investigate the causal effects of informal care on health. In a cohort study, Hajek et al. (2017) use the fixed-effects model and find that higher levels of social support are associated with an increase in functional ability in Germany. The fixed-effects model has the advantage of focusing on within-individual variations and controlling for all time-invariant omitted variables. However, this cannot solve the endogeneity problem of health selection when receiving informal care. As health may be influenced by informal care, it can be considered an important determinant of receiving informal care. Older people with poor health are more likely to receive help from their families. More advanced longitudinal studies are required to investigate the causal pathway from informal care to health.

A commonly used method to reduce reverse causality is to introduce a time lag between informal care and health, that is, to examine the effect of informal care in the previous wave on health in the subsequent wave. Rodríguez-Artalejo et al. (2006) use hospital readmission

as a health outcome indicator and find that, after the first infarction, those who live with or have close contact with family members have a lower rate of hospital readmission during a median follow-up of 6.5 months. Using the Cox proportional hazards regression model, Schmaltz et al. (2007) find that those who do not have family support at the time of hospitalisation have a significantly increasing risk of death after 3 years. Using functional ability as an indicator, Hays et al. (2001) find that more support in daily activities from family members protect against worsening functional ability at the 1-year follow-up in a cohort study in the US. Berard et al. (2012) find that family support has a protective effect on functional health outcomes at the 1-year follow-up among older people with heart failure in Canada. Using hierarchical multiple linear regression models, Cho et al. (2013) find that older people with informal carers have less functional reliance at the 1-year follow-up at home health care centres in the US.

Several studies have examined the long-term effects of informal care. Based on two large national prospective studies in the United Kingdom, Smith et al. (2021) use Cox regression models and find that stroke patients with family support have a lower risk of hospitalisation for a stroke event during the follow-up period of 7 years. In Finland, the Netherlands, and Spain, Zunzunegui et al. (2005) show that social support is negatively associated with the prevalence of functional limitations, and that family support appears to have a stronger effect on the maintenance and restoration of functional ability at the 10-year follow-up. Using Cox regression models, Sonnenberg et al. (2013) show evidence that spousal support predicts lower depression scores at the 13-years follow-up in Amsterdam.

On the contrary, some longitudinal studies using similar methods have concluded that receiving informal care may have a negative effect on the health of older people. Drawing data from the Longitudinal Ageing Study Amsterdam in 1992–1995, Penninx et al. (1997) use Cox proportional hazard models to show that receiving a high level of daily care is associated with a higher mortality rate during a follow-up of 29 months. Drawing longitudinal data from a population-based sample of older African Americans and Whites living in North Carolina, Mendes de Leon et al. (2001) use weighted proportional odds models to identify functional health as a function of family support and other variables. They find that daily care is strongly associated with an increased risk of functional impairment during follow-up. Based on a sample of community-dwelling older people who were interviewed in one or more waves of the Health and Retirement Study between 1998 and

2006, Lin and Wu (2011) extend an autoregressive cross-lagged model to construct three cycles of the relationship between functional limitations, depressive symptoms, and informal care receipt. The results show that receiving informal care in daily life increases functional impairments and depressive symptoms, and these negative effects persist over time.

Although it is common to use a lagged model to examine the causal effects of informal care on health, this method cannot completely address endogeneity. Alternative designs or approaches are useful for further testing causal mechanisms, but studies employing these approaches are limited. Using the instrumental variable approach, Barnay and Juin (2016) use four instruments for informal care: 1) the proportion of daughters, 2) having at least one child who has no child, 3) having at least one child who has no partner, and 4) having at least one child who lives nearby (the same building, town, or department). After addressing endogeneity, the results show that informal care reduces the risk of depression among older people in France.

4.3.2 Review of studies in Asian countries

Hu and Li (2018) argue that people in different social and cultural contexts may interpret the meaning of informal care differently. In particular, independence is highly valued among older people in Western countries; however, it is not recognised as an important issue for older people in Asian countries. Influenced by Confucianism, older people in Asia take pride in their dependence on adult children and consider themselves fortunate if they receive care from family members. Therefore, the research findings obtained in Western countries may not be generalisable to Asian countries.

Most cross-sectional studies have demonstrated the protective effects of informal care on health in Japan, Korea, and Singapore. Drawing data from the first wave of the Nihon University Japanese Longitudinal Study of Aging, Tiedt (2010) find that receiving care from family is associated with lower rates of depression. Based on the Japan Gerontological Evaluation Study in 2006, Tsuboi et al. (2016) use multiple linear regression models and find that spousal care is associated with fewer depressive symptoms. Using data from the first wave of the Korean Longitudinal Study on Health and Ageing, Shin et al. (2008) find that a lack of support from spouses or children is associated with a higher risk of depression. Drawing data from the second wave of the Panel on Health and Ageing of Singaporean

Elderly, Ang and Malhotra (2016) use structural equation modelling to examine the mediating role of personal mastery in the relationship between received social support and depressive symptoms. The results show that receiving informal care often protects against depressive symptoms by improving older people's sense of personal mastery. Hashimoto et al. (1999) provide evidence that living with a spouse or other family members is associated with fewer depressive symptoms at the 1-month follow-up.

Previous studies in China have yielded mixed results. Using cross-sectional data from Guangzhou, Wu and Mok (2007) find that receiving daily care from family members is associated with more depressive symptoms in a sample of 204 older people with functional limitations. In contrast, Gong et al. (2012) find that support from family members is associated with a lower risk of depression in a sample of 1,317 older people in Hubei Province. In a sample of 209 community-dwelling older people in Shanghai, Wang and Zhao (2012) show that lower family support is associated with more depressive symptoms. However, these study results may not be applicable across the country because they are limited to older people in a single province. A small sample size may affect the reliability of the results because it increases variability, which may lead to bias. Based on the first wave of the Chinese Longitudinal Health Longevity Survey, Chen and Short (2008) find that receiving care from a daughter is associated with a higher level of mental health than receiving care from a son. These studies do not account for selection bias that exists between informal care, health, and confounding factors. Based on data from the first wave of the China Health and Retirement Longitudinal Study (CHARLS), Wu and Lu (2017) use the propensity score matching method to reduce the possible influence of selection bias and confounding factors. The results show that informal care could improve older people' health by improving their health behaviours, such as controlling smoking, diet regulation, weight control, and maintaining exercise.

Compared to cross-sectional designs, longitudinal designs typically comprise thousands of repeated data observations. This enables researchers to apply complex statistical tests to reduce endogeneity bias (Zaefarian et al., 2017). Studies have shown that informal care has a protective effect on health. Using data from the Surveys of Health and Living Status of the Elderly in Taiwan, Chao (2011) use random effects models to show that receiving care in daily activities is associated with fewer depressive symptoms over 14 years. Based on three waves of data in the survey in Anhui, Wang and Li (2011) use the individual growth model

and find that informal care receipt is associated with better life satisfaction and fewer depression scores over five years. Based on the same dataset, Cong and Silverstein (2008a) further find that receiving care from a daughter-in-law is associated with fewer depressive symptoms than from a son. Based on data from the first three waves of the CHARLS datasets, Hu and Li (2018) use a multilevel dynamic regression model and find that informal care has a protective effect on older people and slows down the progression of functional limitations during the first two years. Based on the latest three waves of the CHARLS dataset, Zhang and Harper (2022a; 2022b) use the random effects models to find that informal care has a protective effect on older people's mental health and self-rated health. Receiving care from a son (or a daughter-in-law) is associated with fewer depressive symptoms and better self-rated health than from a daughter (or a son-in-law).

In contrast, some longitudinal studies have shown the negative effects of informal care receipt on health. Chou and Chi (2003) find that older people who received care from family members reported more depressive symptoms three years later in a sample of 544 older people in Hong Kong. Based on three waves of data in the survey in Anhui, Wang and Li (2011) use the individual growth model to show that receiving informal care accelerates the decline of functional ability over five years. Using the same datasets and methods, Wang and Gao (2011) find that receiving care from adult children accelerates the decline in cognitive function over five years. According to Hu and Li (2018), while receiving informal care is associated with a slower decline in functional ability within two years, the protective effects are not as strong four years later, weakening, and even disappearing as care intensity increases.

It is difficult to address endogeneity using a non-experimental dataset. Endogeneity caused by reverse causality and confounding factors may not be completely addressed in random effects, individual growth, and multilevel dynamic regression models. Other designs or approaches might be useful in identifying the causal effects of informal care on health; however, existing studies in this regard are limited. Using the instrumental variable approach in longitudinal datasets, Wu et al. (2018) use the number of children and age of the eldest child as instruments for informal care and find that increasing informal care intensity significantly reduces the chances of falls and other accidents.

4.3.3. Research gap

The contradictory findings regarding the relationship between informal care and health can be attributed to several factors. Informal care has been defined and measured in different studies. It is frequently studied from three perspectives: financial, instrumental, and emotional. Many studies have treated informal care as a single measure, making it impossible to distinguish the role of instrumental support from other types of support. Therefore, the role of instrumental support—that is, care in ADLs provided by family members, friends, or relatives (the definition of informal care in this thesis)—remains unclear. As the primary goal of providing informal care is to maintain or slow the decline of functional ability, investigating this specific type of support is especially important; this thesis aims to extend and develop the existing literature in this area.

Recent studies on this topic have been mainly conducted in Western countries, where family structure and ideology are different from those in Asian countries. Western countries place greater importance on individualism, whereas Asian countries lay emphasis on familism. Confucianism outlines fundamental relationships in society (e.g. wife and husband, parents, and children) and defines the roles and responsibilities within these relationships. Under such a value system, older people in China expect to receive help from family members instead of regarding themselves as a burden on their carers. Meanwhile, people care for their spouses or parents not only out of emotional attachment but also out of a strong sense of obligation as a family member. Thus, people in various social and cultural contexts may interpret informal care differently, and findings from studies in Western countries may not be applicable to China.

The intensity of informal care provided to older people varies greatly. An increase in the care hours limits caregivers' time for work or to fulfil other responsibilities in life, making them feel overburdened. In some cases, around-the-clock caregiving is required, which may result in further stress for caregivers (Hu and Li, 2018). Moreover, stress and burnout are likely to increase the frequency and intensity of negative interactions between older people and caregivers. These negative interactions have been shown to increase depressive symptoms and the vulnerability of older people to illness and functional limitations (Lin and Wu, 2011). Furthermore, these negative effects may challenge the boundaries of the buffering effects of social values in China. In comparison to a large number of studies focusing on whether

people receive informal care, little is known about the effect of informal care intensity on care recipients' health.

Endogeneity is the main challenge in examining the effects of informal care on health. This is partly caused by reverse causality, which occurs when the independent and dependent variables simultaneously cause each other and the causal effects run reciprocally (Wooldridge, 2012). Informal care may influence health, but health may also affect the informal care receipt. Existing studies in China largely use cross-sectional or longitudinal data collected from some areas of the country, which are biased towards reverse causality or lack generalisability. To the best of our knowledge, only one longitudinal study conducted by Hu and Li (2018) use a nationally representative sample to investigate the effect of informal care in the previous wave on functional ability in the next wave. Using longitudinal data from a representative national survey, this thesis contributes to the limited literature by examining the lag effect of informal care on older people's functional abilities and depression.

The effects of informal care vary according to individual characteristics. For example, Ang and Malhotra (2016) find that the protective effects of informal care against depressive symptoms are much stronger in women than in men. Mendes de Leon et al. (2001) show that the adverse effect of informal care on functional ability is much greater among Whites than African Americans. Wu et al. (2018) find that the protective effects of informal care in reducing the occurrence of accidents are more pronounced among older people in rural areas than those in urban areas. However, only a few studies have examined the various effects of informal care on health according to socioeconomic status. According to a longitudinal study in Germany, those with a lower socioeconomic status have a stronger association between receiving informal care and better mental health (Zwar et al., 2019). In China, there is still a large gap in the literature regarding the heterogeneous effects of receiving informal care on health by income.

4.4 Effect of informal care receipt on health care utilisation of older people

Most existing studies focus on the relationship between informal and formal care, while the relationship between informal care and health care utilisation remains largely under investigated. Moreover, most recent studies on this topic are from the US and European countries.

4.4.1 Review of studies in Western countries

Recent cross-sectional studies have provided mixed findings on the relationship between informal care and health care. Drawing data from the Spanish National Health Survey in 2003, García et al. (2008) use binary logistic regression to analyse the relationship between informal care and health care use among older people in Spain. The results show that, after controlling for need-related and socioeconomic factors, older people with functional limitations who receive informal care are less likely to consult physicians than those who do not receive care. By contrast, Bremer et al. (2017) conduct a study based on cross-sectional data generated by a large European research project. The results of the linear regression models show that a higher amount of informal care received is associated with a higher number of outpatient visits among older people with dementia in Europe. Condelius et al. (2010) perform a multiple logistic regression analysis to investigate the relationship between informal care and health care utilisation among older people in Sweden. They find that informal care is positively associated with contact with physicians in outpatient care, but not with hospital admissions. Based on data from the first wave of the Survey of Health, Ageing, and Retirement in Europe, Bolin et al. (2008) used ordinary least squares regression models to show that more hours of informal care increase the probability of outpatient visits and hospitalisation in Europe.

Several longitudinal studies have been conducted to investigate the relationship between informal care and health care to reduce potential bias. Kehusmaa et al. (2013) use data from a geriatric rehabilitation program for frail older people in Finland from 2002 to 2007 to examine the relationship between informal care and public care expenditure on elderly care. The results of the hierarchical multilevel regression models show that the availability of informal care considerably reduces public health care expenditures. Based on data from four waves of the Swiss Household Panel survey, Weaver and Weaver (2014) examine the effect of informal care availability on hospitalisation in Switzerland. A two-part model with region

and time fixed effects is estimated to determine the effect of informal care availability on the likelihood of lagged hospitalisation and length of stay, conditional on hospitalisation. The results show that informal care availability has no effect on the likelihood of hospitalisation but significantly reduces the length of stay. As this study focuses on the entire adult population, the findings may not be applicable specifically to older people. Based on a major database of 532 Italian stroke patients enrolled in the period 2007–2008, Torbica et al. (2015) investigate whether the presence of a potential caregiver and the amount of informal care provided are associated with the use and costs of health care services, in particular rehabilitation services in the post-acute phase. The results of longitudinal log-linear models show that the presence of informal caregivers is associated with a higher probability of access to rehabilitation services and an increase in health care expenditures. However, as this study is limited to stroke patients, the findings may not be applicable to the entire older adult population.

Many studies that directly link informal care and health care do not account for endogeneity, which is the biggest issue in examining the causal effect of informal care on health care. Endogeneity of informal care is likely to be present for two reasons: simultaneity and omitted variable bias (Van Houtven and Norton, 2004). When older people have health problems, they decide whether to seek health care services, while their children decide the amount of informal care provided. These decisions can occur simultaneously, or they can precede or follow each other. Omitted variable bias is relevant because it raises the issue of unobserved individual heterogeneity. There may be unobserved health characteristics or care preferences that create positive spurious correlations between informal care and health care by increasing the demand for both (Torbica et al., 2015).

The instrumental variable approach is the most commonly used method to address the endogeneity of informal care and health care. Drawing data from a nationally representative sample of community-dwelling older people in 1993 and 1995 in the US, Van Houtven and Norton (2004) use the number of surviving adult children and whether the eldest child is a daughter as instruments to investigate the causal effect of informal care on the use of different types of health care. They find that an increase in hours of informal care leads to a decrease in the length of hospital stay and the number of physician visits but an increase in the probability of having outpatient surgery. Van Houtven and Norton (2008) use the same datasets to choose the number of adult daughters, sons, and children with less than a high

school degree as instruments to investigate the causal effect of informal care on health care expenditures. The results show that an increase in the hours of informal care received leads to a decrease in total medical expenditures, primarily by reducing home health and inpatient hospital expenditures.

4.4.2 Review of studies in Asian countries

There have been limited studies on this topic in Asian countries yielding mixed results. Using data from the 2001 wave of the Nihon University Japanese Longitudinal Study of Aging, Hanaoka and Norton (2008) use a linear probability model to show that informal care from adult children reduces the use of home health care and outpatient care. In contrast, based on the 2013 Japanese Study of Ageing and Retirement, Chen et al. (2017) use the ordinary least squares, logit, and bivariate probit models to show different results. They find that older people with informal caregivers are more likely to use more health care services. These two cross-sectional studies fail to address the endogeneity caused by reverse causality and unobserved individual heterogeneity, potentially leading to bias.

Related studies in China have been scarce and mixed. Based on two waves of the China Health and Retirement Longitudinal Study, Chen et al. (2022) use negative binomial regression models to show that informal care increases the use of both outpatient and inpatient care, but they do not consider reverse causality between informal care and health care. Taking endogeneity into consideration, Lin et al. (2014) use the distance between children and parents as the instrument to show that more hours of informal care reduce the probability of using outpatient care, but outpatient care expenditure is not investigated in this study. Using the number of surviving adult daughters as the instrument, Huang and Fu (2017) find that informal care has no significant impact on health care use or health care expenditures; however, this study do not distinguish the effect of informal care on different types of health care, such as outpatient and inpatient care. Yu and Jin (2018) use four variables as instruments: the number of surviving adult children, whether the eldest child is a boy, whether the eldest child is over the age of 55, and the percentage of boys in children. They find that receiving informal care increases the probability of using outpatient and inpatient care, and this positive effect is much stronger for the oldest old. However, this study does not consider care expenditure.

4.4.3 Research gap

The lack of consistent findings can be explained by several factors. The relationship between informal care and health care is likely to differ according to the health care type (Bonsang, 2009; Van Houtven and Norton, 2004). Informal carers can provide nutritious food and basic assistance in daily life, helping older people develop healthy diets and habits, such as taking medicine on a regular basis. When their need is met, older people may not seek those types of health care that require low-level skills, such as health consultation. However, this negative relationship may not apply to high-level health care skills, such as complex surgeries and professional post-acute care. Even if older people receive sufficient care from family members, their need for highly qualified and specialised care may not be met. For example, older people with common knee injuries not only need informal carers to assist them in performing daily activities, such as indoor transferring, but also professional surgeons to perform knee surgeries to restore or maintain their health. When older people's need is beyond a certain point, health care cannot be replaced by informal care, and both are necessary to meet their need. Therefore, this thesis distinguishes the effects of informal care on different types of health care.

Endogeneity of informal health care is the main methodological issue. The decisions on informal care and health care are jointly determined. Adult children make decisions about providing care to their older parents in response to changes in health, and older parents make decisions about seeking health care when health need arises. This raises the concern of reverse causality or omitted variable bias, leading to a spurious positive correlation between informal care and health care. Using an instrumental variable approach with longitudinal data, this thesis contributes to the limited literature by examining the causal effect of informal care on various types of health care utilisation and expenditures.

The effect of informal care on health care use may differ by individual's characteristics. Some researchers have investigated heterogeneous impacts from the perspective of informal care sources. For example, Hanaoka and Norton (2008) provide evidence that the effects of informal care provided by adult children differ significantly by gender and marital status. Unmarried daughters are more protective of health care costs than daughters-in-law are. According to Van Houtven and Norton (2008), children are less effective caregivers than their spouses. However, no study has examined the diverse impacts by socioeconomic status.

Thus, this thesis extends the current literature by considering the causal effects of informal care on health care use across different income groups.

4.5 Conclusion

In this chapter, I have discussed the existing literature on socioeconomic inequalities in LTC utilisation, the effect of receiving informal care on health, and the effect of receiving informal care on health care utilisation. China provides an interesting context for studying inequalities in LTC utilisation. The need for LTC will continue growing over the next few decades, while the demographic transition, rural-to-urban migration, and dramatic increase in female labour force participation will likely reduce the supply of informal care. This may result in the need to expand formal care services. In this context, it would be helpful to examine and gain a comprehensive understanding of socioeconomic inequalities in informal care receipt in China. This thesis contributes to the limited literature using concentration indices and longitudinal data.

As informal care is a manifestation of social relationships embedded in specific social and cultural contexts, people from different cultural groups interpret informal care differently. Thus, findings about the effect of informal care receipt on older people's health in Western studies may not be generalisable to China. Additionally, concerns about reverse causality and selection bias complicate the interpretation of studies. The effect of receiving informal care on health may be biased because those with poor health are more likely to receive informal care. The methods used in many Chinese studies are vulnerable to reverse causation. Moreover, some studies in Western countries have found that the effect of informal care is dependent on the adequacy of support and individual characteristics; however, few studies in China have investigated this relationship in detail. By using advanced methodologies in longitudinal data, this thesis aims to examine the effect of receiving informal care on older people's health, the effect of informal care intensity on health, and explore whether those with lower income, who may receive both lower amounts and quality of care, have poor protective effects on health compared with those with higher income.

The effect of receiving informal care on health care utilisation remains largely unknown. Existing studies lack consistency, highlighting the complexity of this relationship, which may

be partly explained by the endogeneity caused by simultaneity and unobserved individual heterogeneity. In addition, studies show that the effect of informal care on health care varies by health care type (Bonsang, 2009; Van Houtven and Norton, 2004). Informal care is likely to reduce the use of health care that requires low-level skills, such as health consultation, but it may not replace health care that requires high-level skills, such as complex surgeries. Furthermore, socioeconomic status may differently influence decisions and preferences for both informal care and health care, but none of the aforementioned studies examined the heterogeneous effect of socioeconomic status. Based on longitudinal data, this thesis extends the literature by addressing the endogeneity of informal care on health care by examining the causal effects of informal care on outpatient and inpatient care utilisation and expenditures, as well as by examining the heterogeneous effect of informal care on health care by income. The following section outlines the data and methods used to address these research gaps.

Chapter 5. Data and methods

5.1 Introduction

Previous chapters introduced the context of income-related inequalities in informal care in China, provided an overview of the conceptual frameworks, and presented a scoping review of existing literature related to the research questions. This chapter describes the analysed datasets and statistical methods employed to model the data. In the first section, the design of the Chinese Longitudinal Health Longevity Survey, representativeness and characteristics of the sample, and quality of these datasets are outlined. The second section introduces some need-related and non-need/socioeconomic variables which are used in all three empirical chapters. The third section discusses methods used to analyse the research questions. In particular, concentration indices and random effects model in the longitudinal data are applied to determine the income-related inequalities in informal care among older people; lagged fixed effects model is used to examine the effects of receiving informal care on the physical and mental health of older people; a two-part model and the instrumental variable approach are used to investigate the causal effects of receiving informal care on the health care utilisation of older people. Noteworthily, this section only provides an overall introduction of basic concepts or steps to construct the indices or model; detailed methods will be discussed separately in each empirical chapter.

5.2 Data: Chinese Longitudinal Health Longevity Survey (CLHLS)

This thesis draws on data from a longitudinal individual survey dataset—the CLHLS, which is an ongoing, publicly available, international collaborative project between Peking University, Duke University, and Max Planck Institute for Demographic Research. Initiated in 1998, the CLHLS is the first national longitudinal project to fill the data and knowledge gaps for scientific research and policy analysis concerning healthy ageing. Its general goal is to investigate the determinants of older people's health and longevity in China from a multidisciplinary perspective. It has the world's largest sample of the oldest old (aged 80 and over), who are most likely to need health and social care, and a compatible sample of younger older people (aged 65–79), which has not been adequately represented in previous surveys due to small sample size. It provides information on the impact of social, behavioural, environmental, and biological factors on human health and longevity. Important measures include demographic, family structure, living arrangements, self-rated health, chronic disease,

care need and costs, psychological characteristics, socioeconomic status, carers, family support, daily living activities, cognitive function, and behavioural risk factors related to mortality and healthy ageing. Such information draws attention to scientific studies, sound policymaking, and practical program interventions aimed at enhancing the health of older people in Chinese society.

The CLHLS conducted face-to-face interviews with individuals in 1998, 2000, 2002, 2005, 2008–2009, 2011–2012, 2014, and 2017–2018, and continues to do so using internationally compatible questionnaires. The sampling design of the CLHLS adopts a multi-stage disproportionate and targeted random sampling method, considering the need for a representative sample, methods for collecting reliable data, and a feasible fieldwork program. The sample of Chinese older people is randomly selected from nearly half of the cities or counties in 22 out of the 31 provinces of Mainland China. The 22 provinces cover the North (Beijing, Tianjin, Hebei, Shanxi), Northeast (Liaoning, Jilin, Heilongjiang), East (Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong), Central (Henan, Hubei, Hunan, Guangdong, Guangxi) and West (Chongqing, Sichuan, Shaanxi). The populations of these provinces constituted approximately 985 million persons—85% of China's total population in the 1998 baseline survey. In the baseline, the CLHLS aims to interview all centenarians who voluntarily agreed to participate in the study in the sampled counties and cities. For each centenarian interviewee, one nearby nonagenarian (aged 90–99) and one nearby octogenarian (aged 80–89) of a predefined age and gender were selected in the same or neighbouring county or city for voluntary participation in the survey. Using the same sampling strategy, three participants (aged 65–79) were surveyed for every two centenarians interviewed, starting with the 2002 wave (Zeng, 2012). Respondents who died, could not be traced, or refused to be interviewed during a subsequent wave were replaced by new interviewees in the same gender and age group during the follow-up waves.

Numerous studies have reported the reliability of these datasets (Zeng, 2012). As age is a key variable in the analysis, the CLHLS uses various sources to verify the ages of the participants, such as birth and marriage certificates; information from household registration booklet; the ages of their siblings, children, and relatives; genealogical records; relevant documents from local ageing committee offices, if available; and reported ages in the form of Chinese zodiac animals (Zeng, 2019). It also verifies the accuracy of age reporting at the aggregate level by using indicators such as the single-age distribution of centenarians, age-

progressive ratio of very old adults (e.g., ages 90 and older), and centenarian density among those aged 80 and over. In comparison to some Western countries, such as the US, Australia, and Canada, the CLHLS's accuracy of age reporting for the oldest-old and younger older adults is relatively good (Zeng, 2019). Additionally, the interview refusal rate among Chinese older people is very low: about 2% among those who were not too ill to participate with proxy assistance. This is likely because several older people and their family members may feel honoured to participate in survey interviews about healthy ageing as they are proud of being a member of a long-lived group. Numerous individuals with functional limitations also agree to participate in healthy ageing studies with the help of a close family member acting as a proxy (Zeng, 2012). Moreover, researchers have conducted extensive evaluations on mortality rate, sample attrition, reliability and validity of major health measures, and the rates of logically inconsistent answers. They conclude generally satisfactory results when compared to other major ageing studies (Gu and Feng, 2015). Thus, many researchers have formally registered as CLHLS data users, and numerous papers using this survey have been published in international peer-reviewed journals that focus on socioeconomic status, health, health care, and LTC (Lin, 2019; Wang et al., 2020; Yu and Jin, 2018).

In China, two major national survey datasets are commonly used to study the older population: The China Health and Retirement Longitudinal Study (CHARLS) and CLHLS. Table 2 summarises the main differences between these two datasets. The CHARLS started later, with only four waves from 2011–2018, whereas the CLHLS started earlier and lasted significantly longer, with eight waves from 1998–2018. The CHARLS aims to collect a nationally representative sample of Chinese residents (aged 45 and older), whereas the CLHLS is the first national survey focusing on older people (aged 65 and older) in China. The CHARLS uses a multi-stage stratified sampling strategy in the county or district and village sampling stages, with probability proportional to the size of the unit sampling. Alternatively, as previously stated, the CLHLS interviews every centenarian who survived and volunteered to participate in the survey as far as they could in the survey area. One nearby nonagenarian (aged 90–99) and one nearby octogenarian (aged 80–89) of a pre-designated age and gender are chosen in the same county or city for each centenarian interviewee, such that the number of males and females aged 80–99 is roughly equal. Due to the differences in the study population and sampling strategy, the age distributions of these two datasets are vastly different. The sample in CHARLS is primarily concentrated between the ages of 45 and 65, with samples aged 85 and older being extremely small. By contrast, the

CLHLS contains a large number of older people aged 70 to 95, and the sample size for people under 70 is very small (Zeng, 2019). Based on the definition of informal care used in this thesis, which is discussed in Chapter 3, it focuses on older people with ADL limitations. This implies that the age of this study group should be older; thus, the CLHLS is ideal for empirical analysis. Additionally, the CLHLS has a larger sample size, which may reduce potential bias. Since the first three waves did not collect information on primary carers to differentiate between informal and formal care, data for this thesis is derived from the 2005, 2008, 2011, 2014, and 2018 interviews. This thesis is exempt from ethics approval as it analyses secondary data and the participants provided informed consent when they agreed to participate in the CLHLS survey (Zeng, 2012).

Table 2. Main differences between the CHARLS and the CLHLS

	CHARLS	CLHLS
Waves	2011, 2013, 2015, 2018	1998, 2000, 2002, 2005, 2008–2009, 2011–2012, 2014, 2017–2018
Study population	Individuals aged 45 and older	In 1998, 2000: the oldest-old aged 80 and older From 2002: add those young elders aged 65–79 as a comparison
Sampling strategy	Multi-stage stratified sampling strategy with probability proportional to the size	Multi-stage disproportionate and targeted random sampling strategy
Sample size	Total number of 77,221 interviews with individuals in the four waves	Total number of 112,717 interviews with older people in the eight waves

5.3 Variable specifications

Based on the literature on informal care in China (Du and Wang, 2017; Hu and Ma, 2018; Peng et al., 2017), I control for a set of need-related variables and non-need/socioeconomic variables. It is worth noting that this section only includes some common need-related and non-need/socioeconomic variables which are used in all three empirical chapters; some specific covariates included in the analysis will be introduced in each empirical chapter.

Need-related variables

Need-related variables include age, gender, self-rated health, number of chronic diseases, number of limitations in ADLs, and cognitive function. Age is a continuous variable. Gender

is a binary variable with the female set as the reference category. Self-rated health is assessed by the question 'How do you rate your health at present'. Respondents are provided with five choices: very good, good, fair, bad, or very bad according to the feelings of respondents. I classify these answers into three groups, 'bad' (the reference group), 'fair', and 'good'. Number of chronic diseases is a count variable representing the number of chronic diseases the respondent suffered from. The ADL items are adopted from the Katz scale. It is measured by six activities: bathing, dressing, indoor transferring, toileting, eating, and continence. Each item has three response categories: 'able to do without help', 'need some help', and 'unable to do without help'. Number of ADL limitations is a continuous variable based on the total number of six activities respondents are unable to perform or need some help with. Cognitive function is measured using the Chinese version of the Mini-Mental State Examination (MMSE). The Chinese version of the MMSE scale is translated from the international standard of the MMSE questionnaire considering cultural and socioeconomic conditions of Chinese older people, so that all question items in the test could be easily comprehended and answered. and is constructed from 24 items in the original survey. It comprises six dimensions: five items for orientation, three for registration, one for naming, five for attention and calculation, three for recall and seven for language. The total score of the Chinese MMSE ranges from 0 to 30 points, with higher scores indicating better cognitive functions. I construct a single score which is then normalised. The validity and reliability of the Chinese MMSE measure has been carefully tested and verified in existing literature (Deng and Liu, 2021; Li et al., 2017; Zhang et al., 2018).

Non-need/socioeconomic variables

Non-need variables include income, education, marital status, place of residence, living arrangement, number of surviving adult children, the availability of financial assistance from children, and the availability of community care services.

One of the key variables in this thesis is income, which refers to household per capita income of older people. The survey only collects information on income based on the question, 'What was the total income of your household last year'. Household size and demographic composition are taken into consideration to adjust household income using the Equivalent Scale, following the form: $AE = (A + PK)^F$, where A is number of adults in the household, K is number of children in the household, P is proportion of a child treated as an adult, and F

is the scale economy factor. In this thesis, P is 0.3, and F is 0.75 (Citro and Michael, 1995; Yang, 2013). It is a continuous variable. Because income-related inequalities are sensitive to the values at the bottom and top of the income distribution, the top 0.5% and bottom 0.5% of the adjusted household per capita income distributions were trimmed following the convention (Jenkins, 2015).

Education is a categorical variable. Respondents are asked 'How many years did you attend school?', according to the answers of 0 years, 1-6 years, and 7 years or more, education is classified into three categories: no education (the reference group), elementary school, and middle school and above. Marital status is categorised into three groups: married (the reference group), widowed, and other (separated/divorced/never married). Place of residence is a categorical variable, including three groups: city (the reference group), town, and rural areas. Like many developing countries, China has a dual economy structure where highly developed industrial sectors in cities co-exist with backward agricultural sectors in rural areas, and towns play an important role in China's urbanisation process by linking cities and rural areas. These rural-town–urban variations directly affect older people's access to informal care, preferences for informal care and health outcomes. Therefore, it should be incorporated into analysis. 'Living arrangement' is a binary variable indicating whether the individual lived with family members.

5.4 Methods

Methods used for each empirical chapter are described in part of each chapter. Here, I outline briefly the overall methods used for each of them:

This thesis uses concentration indices and random effects model in the longitudinal data to determine the income-related inequalities in informal care among older people (Chapter 6). By applying approaches from the economics of inequalities in health or health care literature, this thesis estimates income-related inequalities in informal care receipt across income groups.

Lagged fixed effects models are used to examine the effects of informal care receipt on the physical and mental health of older people (Chapter 7). This model offers a powerful toolbox to reduce endogeneity caused by reverse causality.

Instrumental variable approach is used to investigate the causal effects of informal care receipt on the health care utilisation of older people (Chapter 8). This econometric approach is used to address endogeneity and omitted variable bias in observational data. The following section provides an overall introduction to each of these methods.

RQ1: Income-related inequalities in informal care among older people with functional limitations: concentration indices and random effects model

Concentration Index (CI) is a particularly popular choice for the measurement of socioeconomic-related inequality in health. It captures the extent to which health differs across individuals ranked by some indicator of socioeconomic status (O'Donnell et al., 2016). Specifically, it compares the cumulative distribution of health with the cumulative distribution of the population ranked by socioeconomic status. Kakwani (1980) first introduced and discussed the measurement of income distribution and poverty in the book *'Income Inequality and Poverty: Methods of Estimation and Policy Applications'*. Kakwani et al. (1997) then published a paper in the *Journal of Econometrics*, extending the discussion to the use of CI, explained why this index is superior to other indices used in empirical literature in health inequalities. In the book *'Analysing Health Equity Using Household Survey Data'*, O'Donnell et al. (2007) described how socioeconomic inequalities in health can be measured using CI. This method has been widely used by international organisations, government bodies, and academic institutions to measure inequalities in health and health care, such as income-related inequalities in self-rated health and ambulatory care use (Shin and Kim, 2010; Yang and Kanavos, 2012). With the development of LTC, CI has become a commonly-used tool in studying inequalities in LTC utilisation to quantify the degree of socioeconomic-related inequalities in access to LTC services among older people, for example, income-related inequalities in access to home- and community-based formal care services (García-gómez et al., 2015; Vincenzo et al., 2017). It provides a holistic assessment of inequalities rather than calculating the mean value for each income quintile, which is common in the existing literature (Gravelle, 2003; O'Donnell et al., 2007).

As mentioned in Chapter 3, inequalities in care utilisation exist across a wide range of variables. O'Donnell et al. (2007) classified inequalities into 'legitimate' (those influenced by age, gender, functional limitations, or other need-related factors) and 'illegitimate' inequalities (arising from circumstances beyond individual's own control). Policymakers may be less concerned with legitimate inequalities because these are usually reasonable or acceptable. By contrast, policymakers would want to avoid illegitimate inequalities. Therefore, a measurement of socioeconomic inequalities—to control for need-related inequalities or identify only non-need related inequalities—would be ideal for policymakers. To measure socioeconomic inequalities that reflect only non-need related differences, indirect standardisation of need-related variables is used. The goal of indirect standardisation is to remove variances in care utilisation caused by need-related variables, leaving only the inequalities caused by socioeconomic factors, namely, Horizontal Inequity Index (HI) (O'Donnell et al., 2007).

The methods to calculate and construct CI and HI involve four steps: (1) estimate a model of the determinants of a care utilisation variable using a set of need and non-need variables; (2) calculate the CI for the actual care utilisation variable; (3) predict (indirectly) need-standardised care utilisation for each care utilisation variable; and (4) calculate the HI showing inequalities only driven by socioeconomic factors. A negative value indicates a disproportionate concentration of the care utilisation variable among the poor and a positive value indicates the opposite (O'Donnell et al., 2007).

As health economists have found that the traditional CIs may not be the best estimation of income-related inequalities for binary or categorical variables, the Erreygers's Concentration Index (EI) is proposed and has proven to provide a more accurate estimation for binary dependent variables (Erreygers, 2009). The processes of conducting indirect standardisation and calculating EI will be discussed in detail in Chapter 6.

Longitudinal data (i.e., data that contain observations on different cross sections across time) are then used to further examine the relationship between income and care utilisation. A major advantage of longitudinal data is increased precision in estimation. This is the combined result of the reduction in estimation biases arising from aggregating groups into a single time series and the increase in the number of observations owing to the combination of several time periods of data for each individual (Wooldridge, 2012). Another advantage of

longitudinal data is the possibility to help control the effect of omitted variables. Longitudinal data contain information on both the intertemporal dynamics and individuality of the entities, which might be used to control for the effects of confounding variables (Hsiao, 2011). The third advantage of longitudinal data is the possibility of learning more about the dynamics of individual behaviours than is possible from a single cross section. By providing sequential observations for multiple individuals, longitudinal data allow us to distinguish inter-individual differences from intra-individual ones and build the appropriate recursive structure to study the issue through a before-and-after effect (Hsiao, 1985).

The fixed effects (FE) and random effects (RE) models are commonly used for longitudinal data. The FE model assumes that the unobservable individual effects are correlated to the independent variables, while the RE model assumes that they are uncorrelated with the independent variables. Both models have pros and cons: The FE model is advantageous because the bias arising from the correlation between the unobserved effects and included explanatory variables can be eliminated. The RE models enable estimation of the effect of time-invariant variables (which is not possible in FE models) and derivation of efficient estimators that use both within and between individual variations. However, this predisposes the model to bias arising from unobserved heterogeneity between individuals (Hsiao, 2011). The Hausman test offers a criterion to choose between the two models. Essentially, the test aims to assess whether there is a correlation between the unobservable effects and independent variables in the model. The null hypothesis is that there is no correlation between the two (Wooldridge, 2012). In practice, a failure to reject means either that the FE and RE estimates are sufficiently close such that it does not matter which is used, while a rejection means that the key assumption in the RE model is false and that the FE model is preferred.

In some studies, the RE model might be appropriate. When studies pay more attention to correlation rather than causation, it may be sufficient to use the RE model to measure the extent of association (Cameron and Trivedi, 2005). Moreover, the RE model uses both within and between individual variation, while the FE model exploits within-individual variation only. This means that the RE model typically exhibits less sampling variability than the FE model, and the latter would be imprecise when intra-individual variations are low in comparison to inter-individual variations in the analysis (Allison, 2009). In this thesis, considering the substantial loss of information that comes from discarding the between-

individual variation, the RE model is used to analyse the association between income and informal care among older people with functional limitations in China. While this study cannot test the causal mechanisms underlying associations observed, it does provide important insight into the magnitude of income-related inequalities in informal care. Please refer to Chapter 6 for the detailed equations.

RQ2: Effect of informal care receipt on physical and mental health of older people: lagged fixed effects model

The major attraction of the FE model is the ability to control for all stable characteristics of the study participants, including unobserved ones. The following equations explain this reason clearly: for each i,

$$y_{it} = \alpha_i + \beta X_{it} + \mu_{it}, \quad t=1, 2, \ldots, \text{T and } i=1, 2, \ldots, \text{N} \qquad [5.1]$$

where y_{it} is the dependent variable observed for individual i at time t, X_{it} is the time-variant independent vector for individual i at time t, α_i is the unobserved time-invariant variable vector for individual i at time t, and μ_{it} is the error term.

For each i, the average equation [5.1] over time is as follows:

$$\overline{y_i} = \beta \overline{X_i} + \overline{\alpha_i} + \overline{\mu_i} \qquad [5.2]$$

The FE model eliminates α_i by demeaning the variables using the following within transformation:

$$y_{it} - \overline{y_i} = \beta(X_{it} - \overline{X_i}) + (\alpha_i - \overline{\alpha_i}) + (\mu_{it} - \overline{\mu_i}) \qquad [5.3]$$

Since α_i is constant, $\overline{\alpha_i} = \alpha_i$ and the effect of the unobserved time-invariant variable disappears. Based on the abovementioned equations, we can see that the FE model must meet two requirements. First, the dependent variable must be comparably measured for each individual using a similar metric at two or more time points. Second, the exposure variable of interest must change across these two occasions for at least a fraction of the sample (Allison, 2006). FE estimators, also known as 'within-person' estimators, control for unobserved individual heterogeneity that may be related to the independent variable. It exploits longitudinal data by assessing the association between changes in the independent variable and those in the dependent variable within individuals, thereby controlling for permanent characteristics that vary across individuals.

In this thesis, I apply the FE model to assess whether within-individual changes in informal care receipt are associated with within-individual changes in health outcomes. The FE model controls for potential time-invariant confounders that vary across individuals, such as gender, family background, and pre-existing health. In essence, this model uses individuals as their own control, by comparing their health outcomes when exposed to a given level of informal care receipt with their own health outcomes when they are exposed to a different level of informal care receipt. Assuming that intra-individual changes in exposure are uncorrelated with changes in other variables, the difference in health outcomes between these two periods is an estimate of the association between informal care receipt and health outcomes for that individual (Allison, 2006). Averaging these differences across all individuals in the sample yields an estimate of the 'average treatment effect', which controls for all time-invariant individual variables. Although it does not control for time-variant variables, these variables can be handled conventionally by incorporating them into the regression model.

Furthermore, the FE model can provide additional insights into the potential causal association by controlling for individual heterogeneity (Cameron and Trivedi, 2005). To better examine the direction of causality, a lagged dependent variable model is used. A challenge when attempting to combine the FE models with a lagged dependent variable is choosing the estimation approach (Allison et al., 2017). One method to estimate the lagged FE model is the Arellano-Bond estimation technique, which relies on lagged variables as instruments. However, reportedly, the estimators are not fully efficient and have considerable small-sample bias. Recently, Moral-Benito (2013) have explored maximum likelihood estimation within the framework of structural equation models to address some issues in the Arellano-Bond estimation technique, especially when instruments are weak. With this estimation approach, I use lagged informal care receipt to examine whether changes in informal care receipt between waves 1 and 2 are associated with changes in health outcomes between waves 2 and 3, to minimise the potential impact of the reverse causality of health on selection into receiving informal care. To examine whether the effect of informal care receipt on health varies by income, an interaction between informal care receipt and income is further added to the model. Detailed equations will be discussed in Chapter 7.

RQ3: Impact of informal care receipt on health care utilisation of older people: two-part model and instrumental variable approach

The two-part model is designed to model strictly positive variables with numerous zero values, which are consequently formulated as a mixture of binomial and strictly positive distributions. The basic framework is as follows: First, we suppose that an event may or may not occur. When it does occur, one observes a positive random variable. When it does not, the observed outcome takes a zero value, thus becoming a zero-censored variable (Wooldridge, 2012). In practice, this model comprises a Probit or Logit model for the probability of observing a positive-versus-zero outcome and a Linear Probability model/Ordinary Least Squares (OLS) model for the positive outcome, which is conditional on a positive outcome. Duan et al. (1984) present a leading application of this model to forecast medical expenses using data from the Rand Health Insurance Experiment. They first specified a Probit model for whether any medical expenses were incurred during the year:

$$\Pr(Y_i > 0) = \phi(\beta X_i) \quad [5.4]$$

where X is a vector of independent variables, β is the corresponding vector of parameters to be estimated, ϕ is the cumulative distribution function of an independent and identically-distributed error term typically chosen from Logit or Probit distributions (Belotti et al., 2015).

Thereafter, they constructed an OLS model for medical expenses given that some expenses were incurred. Since the expenditure data is asymmetrically distributed in the right thick tail, there are logarithmic changes in the expenditure data:

$$\ln(Y_i | Y_i > 0) = \psi(\beta X_i) \quad [5.5]$$

where ψ is an appropriate density function for $Y_i | Y_i > 0$. Since then, the two-part model has been used to model health care utilisation, which is continuous for the majority of their distribution but has several observations at one or more particular values, such as zero. For example, when modelling the number of doctor visits, one model determines whether a patient visits a physician at all, and a second model determines the consequent number of visits for those with at least one visit. In the CLHLS, a fraction of the sample did not spend any money on health care last year; therefore, a two-part model is introduced in the analysis. The first part is a binary Probit model, which predicts the probabilities of using health care, and the second is an OLS model, which estimates the costs of health care when the expenditure data value is above zero. To examine whether the effect of informal care receipt on health care varies by income, an interaction between informal care receipt and income is further added to the model. The detailed equation will be presented in Chapter 8.

Building on the literature review in Chapter 4, endogeneity is the most common difficulty when examining the impact of informal care receipt on health care utilisation. Endogeneity broadly refers to situations in which an independent variable is correlated with the error term. Endogeneity is quite likely to occur when a confounding variable (i.e., a variable that is correlated with both the independent variable in the model and error term) is omitted from the regression model (perhaps because it cannot be measured directly) or when the dependent and independent variables are codetermined and affect each other. Economists are very concerned with this complication and generally use the instrumental variable (IV) approach to control for endogeneity. If a suitable instrument is identified, causal effects might be estimated in the presence of unmeasured confounding (Wooldridge, 2012). To better describe this approach, the simple regression model is written as

$$y = \beta_0 + \beta_1 x + \mu \quad [5.6]$$

where we think that x and μ are correlated:

$$Cov\,(x, \mu) \neq 0 \quad [5.7]$$

To obtain consistent estimators of β_0 and β_1 when x and μ are correlated, we need additional information such as a new variable that satisfies certain properties. We suppose that we have an observable variable z that satisfies these two assumptions: (1) z is uncorrelated with μ, that is,

$$Cov\,(z, \mu) = 0 \quad [5.8]$$

(2) z is correlated with x, that is,

$$Cov\,(z, x) \neq 0 \quad [5.9]$$

Then, z is called an instrumental variable for x, or sometimes, simply an instrument for x. In other words, two main criteria help find a reliable instrument. First, z is causally associated with x but not μ, and second, z is not a direct cause of the dependent variable y (it is only indirectly associated through the independent variable x). The requirement that the instrument z satisfies [5.8] is often referred to as instrument exogeneity or exclusion restriction.

The most common instrumental estimation technique is the two-stage least squares estimator (Cameron and Trivedi, 2005). The first stage predicts the expected value of the independent variable based on the instrument in a model:

$$E[x|z] = \alpha_0 + \alpha_1 z \quad [5.10]$$

The second stage then predicts the dependent variable y as a function of the predicted independent variable from the first stage:

$$E[y|z] = \beta_0 + \beta_1 \hat{E}[x|z] \quad [5.11]$$

where the parameter β_1 is equivalent to the instrumental variable estimator. Any measured covariates to predict the independent variable must be added in both the first and second stage equations.

Following the strategy used in existing studies, I further use the IV method to address endogeneity to evaluate the causal effect of informal care receipt on health care utilisation. I use an instrument that has been extensively used in the literature: the number of surviving adult daughters. This is believed to be a valid instrument because it is a significant predictor of informal care receipt, and because the gender of a child is determined by random processes and it is not subject to a parent's choice. The assumption, discussed in the empirical chapter, is that the number of daughters only influences health care utilisation by affecting the receipt of informal care (Bonsang, 2009; Van Houtven and Norton, 2004). The choice of the instrument is discussed in more detail in Chapter 8.

As other surveys, the CLHLS has missing values. When considering the potential impact of the missing data on the empirical findings, understanding the data generation process is essential. Missing data are typically grouped into the following three categories (Wooldridge, 2012): the first type is missing completely at random (MCAR), which means the missing data are independent of the observed and unobserved data. In this instance, the missing data reduce the analysable population of the study and statistical power, but do not introduce bias; the second type is missing at random (MAR), which means that missing data are systematically related to the observed but not unobserved data. In this case, missingness can be considered ignorable after controlling for observed characteristics; the third type is missing not at random (MNAR), which means that missing data are systematically related to the unobserved data. In such circumstances, the missingness is related to events or factors, which are not measured by the researcher, leading to potential bias (Mack et al., 2018). Traditional ways to handle missing data include listwise or case deletion, pairwise deletion, and mean substitution, among others.

A widely used method to deal with missing data involves Maximum Likelihood or Multiple Imputation. However, imputation can only be conducted when the missing values are predicted by a set of variables with complete values (Kang, 2013). For the CLHLS, missing values are found in demographic and socioeconomic variables, which are commonly used to conduct imputation, thus making imputation difficult. Therefore, complete case analysis is used in this thesis; that is, some observations that had missing or unreliable values for the variables of interest or the other explanatory variables are excluded. I choose this approach because the proportion of missing values was very small in the CLHLS data, so that exclusion of individuals with missing values is unlikely to impact overall conclusions. For example, the percentage of missing values on income is very low, around 1.8%.

5.4 Conclusion

This chapter introduces the CLHLS datasets, need-related and non-need/socioeconomic variables, and analytic approaches used in the empirical chapters of this thesis (chapters 6-8). Chapter 6 presents the distribution of informal care receipt across income groups, using CIs and the RE model in the longitudinal data. Rather than calculating mean health for each income quintile, CIs have the advantage of providing a holistic assessment of inequalities. The RE model in the longitudinal data exploits both between-and within-individual variation, yield more efficient –albeit more prone to omitted variable bias -coefficients than the FE model. Chapter 7 employs the lagged FE model to examine the effects of informal care receipt on the physical and mental health of older people and heterogeneous effects across different income groups. This model provides insights into the potential causal association between changes in informal care receipt and changes in health outcomes. Using the two-part model and instrumental variable approach, Chapter 8 investigates the impacts of informal care receipt on the health care utilisation of older people and diverse impacts across different income groups. With a valid instrument, this econometric technique can help address the endogeneity of informal care receipt on health care utilisation.

Chapter 6. Income-related inequalities in informal care

Income-related inequalities in informal care: Evidence from Chinese Longitudinal Healthy Longevity Survey[1]

Abstract

This report seeks to examine income-related inequalities in informal care among older people with functional limitations in China. Data are drawn from the 2005, 2008, 2011 and 2014 waves of the Chinese Longitudinal Healthy Longevity Survey. Erreygers's Concentration Index, Concentration Index, and Horizontal Inequity Index are used to examine inequalities in informal care. Random effects model is then used to investigate the relationship between household per capita income and informal care. This study finds that there is no significant association between household per capita income and the probability of receiving informal care. However, there is a significantly positive association between household per capita income and hours of informal care received, indicating that those with higher income receive more hours of informal care compared to those with lower income. The degree of inequalities increases as number of functional limitations increases. The results suggest that lower household income is associated with fewer hours of informal care received, particularly for older people with more functional limitations. Policies are required to provide accessible and affordable formal care services for low-income groups in order to protect their health.

[1] This chapter is based upon a published co-authored paper (with Dr. Wei Yang and Prof. Mauricio Avendano) in Journal of Gerontology: Series B (Wang, Yang, and Avendano, 2021)

6.1 Introduction

Population ageing is a global issue. The number of older people aged 65 and above is predicted to increase from one in eleven in 2019 to one in six in 2050, with 80% of the older people living in developing countries (United Nations, 2019). With the dramatic pace of population ageing, a growing number of older people are losing their ability to live independently due to the physical decline in their performance of basic daily activities (WHO, 2015). This results in growing need for LTC, which consists of informal care and formal care (Burchardt et al., 2018).

Globally, informal care from family members, friends or neighbours remains crucial to fulfil care need. Even in developed countries with well-established LTC systems, such as Europe, more than a third of the total population are informal carers (Verbakel et al., 2017; Zigante, 2018). In developing countries, older people usually have a higher prevalence of functional limitations, but the governments face greater challenges in providing formal care. Individuals seeking formal care either pay a user fee at public formal LTC facilities or use private formal care facilities; however, a significant proportion of older people in developing countries cannot afford these services (Lambert et al., 2017). Hence, the proportions of informal care in developing countries are much higher, and China is no exception.

China has witnessed the most rapid population ageing in the world. Approximately 17% of the Chinese population is currently aged 65 years and older, and this is expected to increase to 35% by 2050, resulting in 487 million older people (United Nations, 2019). The number of Chinese older people with functional limitations has also been increasing over the past decades. Like many other developing countries, China's formal LTC system is still in its initial stage. Most community-based care centres are established very recently. The government has not clearly clarified how these facilities will be funded, which groups of people they will serve and what outcomes they are supposed to achieve in the future (Hu and Ma, 2018). With a long tradition of filial piety, the predominating value in Chinese society is that family members are supposed to be the main providers of care. Thus, care responsibility is mainly reliant on families (Yang and Tan, 2019). In 2015, approximately 16-41 million older people in China have difficulties in performing basic daily activities, among which more than 98% of these people receive care at home (Peng and Wu, 2020).

Despite the important role of informal care, findings about the distribution of informal care receipt across different income groups are mixed in Western countries. Some studies find that older people with higher income have more financial resources to seek for formal paid care, whereas older people with lower income have financial difficulties in buying formal care services, and tend to turn to family members for help (García-gómez et al., 2015; Ilinca et al., 2017). On the contrary, some studies show that older people in higher income groups are more likely to receive both informal and formal care than those in lower income groups (Jang and Kawachi, 2019). Some studies do not find any significant relationship between income and LTC care utilisation (Wu et al., 2014).

However, research on the distribution of informal care by income is limited in China. The majority of studies are basic descriptive studies, such as constructing tables of means and quantiles, or analysing influencing factors of informal care receipt based on regional or cross-sectional data (Hu and Ma, 2018; Peng and Wang, 2017; Peng et al., 2017). To date, limited empirical study has quantified the direction and magnitude of income-related inequalities in informal care receipt in China.

With rapid socioeconomic development and culture changes in recent decades, the meaning of filial piety has been altered from an unconditional duty to take care of older parents to a type of support that is to some extent conditional on older parents' support to adult children (Cong and Silverstein, 2008b). Specifically, adult children may provide care in expectation of future transfers, including bequests (Pezzin et al., 2015). This means that older people with lower income are less likely to receive care from adult children because they cannot give enough money or gifts to adult children in exchange for care. On the contrary, older people with higher income have financial ability to provide future bequests in exchange for care, and thus, their children are more willing to provide care.

Moreover, with accelerated urbanisation, adult children in high-income families may provide more care. Specifically, adult children from low-income families have to migrate to more developed areas for economic necessity. They have less flexibility of time allocation decisions, and they are faced with more difficulties when making harsh decisions between work and care. The long time and space separations between parents and themselves increasingly preventing older parents from accessing traditional routine care. By contrast,

adult children from high-income families may have more flexibility of time allocation decisions, and have sufficient economic capacity to reduce their involvement in economic activities and spend more time caring for their parents (Liu, 2014; Qian, 2017). This leads to the first research question (RQ) and the corresponding hypothesis (H):

RQ1: Does the receipt of informal care vary across older people with different income?

H1: Older people with higher income are more likely to receive more informal care, compared to those with lower income.

The severity of functional limitations may also influence informal care receipt differently by income. Low-income older parents with more functional limitations cannot provide sufficient bequests to adult children, yet they often require higher level of need for care (Soldo and Hill, 1993). This may place heavier pressure on adult children. Therefore, adult children's willingness to care for older parents with lower income but more functional limitations may decrease, and these older parents may be less likely to receive informal care than their counterparts. Therefore, I aim to address the second research question and the corresponding hypothesis:

RQ2: Whether income-related inequality in informal care receipt is larger when number of functional limitations increases?

H2: The degree of the pro-rich inequality increases as number of functional limitations increases.

Against this background, this study narrows the research gap by quantifying the magnitude and direction of income-related inequalities in informal care receipt using nationwide longitudinal data. Using data from the 2005 to 2014 waves of the CLHLS, this study first examines how the distribution of informal care varies across income groups, then examines the relationship between care need, income, and informal care, to assess whether the inequalities in informal care across income increase together with need measured by functional limitations.

6.2 Data and Methods

Data

Since the first three waves did not collect information on the primary carer, data for the present study is based on individuals that participated in any of 2005, 2008, 2011 and 2014 interviews. In the CLHLS, respondents are first asked whether they required assistance in carrying out either item of ADL, including bathing, dressing, toileting, indoor transferring, continence, and eating; if they report that they did, they are then asked to choose their primary carer from the following choices: spouse, children, grandchildren, other relatives, friends, neighbours, social services, or housekeepers. If they report that this is an informal carer (i.e., spouse, children, grandchildren, other relatives, friends or neighbours), they are then asked about the total number of hours they received help from children/grandchildren in the last week. Thus, I limit analysis to older people aged 65 and above with one or more limitations in ADLs. In addition, question on informal care is independent of question on care in nursing homes. Respondents are asked whether they live in nursing homes. No matter whether they live in nursing home or not, they are also asked to choose their primary carer. Because it is difficult to identify the role of income in informal care receipt among those receiving informal care in nursing homes in this survey, I exclude individuals living in nursing homes (N = 442) from our final sample (N = 11,158) to reduce potential bias. Table 3 shows descriptive statistics of the sample.

Table 3. Descriptive characteristics of the sample

Variables	2005	2008	2011	2014
		Mean (SD)/Percentages		
LTC				
No care	1.25	1.00	1.18	1.29
Receiving formal care	7.92	5.64	5.09	2.65
Receiving informal care	90.83	93.36	93.73	96.05
Weekly hours of informal care	43.04 (46.43)	53.61 (53.01)	51.11 (55.99)	51.71 (56.09)
Household per capita income (Yuan)	4298.47 (11536.27)	7763.82 (10976.91)	10717.81 (13369.03)	12756.00(13872.68)
Age	94.52 (8.62)	95.93 (8.03)	93.81 (9.38)	92.96 (9.53)
Gender				
Female	69.34	70.36	65.69	64.63
Male	30.66	29.64	34.31	35.37
Self-rated Health				
Bad	45.57	50.84	41.72	43.69
Fair	27.03	23.00	29.93	31.14
Good	27.40	26.15	28.35	25.17
Number of chronic diseases	1.67 (1.70)	1.27 (1.41)	1.38 (1.56)	1.34 (1.47)
Number of limitations in ADLs	2.80 (1.85)	2.93 (1.85)	2.98 (1.90)	3.01 (1.90)
Cognitive function score	14.28 (10.82)	11.25 (10.51)	14.56 (10.50)	14.89 (10.55)
Education attainment				
No education	83.21	86.38	86.27	85.75
Elementary school	13.76	10.89	11.39	11.88
Middle school and above	3.03	2.72	2.34	2.38
Marital status				
Married	14.31	11.34	19.00	23.04
Widowed	84.05	87.25	79.43	75.45
Other	1.64	1.41	1.57	1.51
Place of residence				

City	34.84	28.92	23.29	19.86
Town	17.54	16.31	28.52	31.90
Rural	47.62	54.77	48.19	48.23
Co-residence with family members				
No	7.45	6.05	9.23	10.60
Yes	92.55	93.95	90.77	89.40
Number of surviving children	3.41 (2.01)	3.41 (1.95)	3.71 (1.95)	3.63 (1.95)
Financial assistance from children				
No	12.33	11.67	24.91	24.50
Yes	87.67	88.33	75.09	75.50
Availability of community care services				
No	88.23	87.16	66.81	61.90
Yes	11.77	12.84	33.19	38.10
N	3,774	3,617	2,297	1,470

Notes: The unit of this study sample is the individual. The study sample is limited to older people with at least one ADL limitation. Mean (SD) is presented for continuous variables, and Percentages is presented for categorical variables. For the weekly hours of informal care, the number of the total sample is 10,370. Specifically, the number of the sample in 2005, 2008, 2011, 2014 are 3,264, 3,481, 2,112, 1,346 respectively.

Variable specification

Dependent variable: Informal care

I construct two dependent variables: (1) LTC receipt, comprising three sets of binary variables: no care received, informal care received as primary source (i.e., primary carer is spouse, children, grandchildren, other relatives, friends or neighbours), and formal community-based care received as primary source (i.e., primary carer is social services, or housekeepers). Previous studies operationalise receipt of LTC into four categories: no care received, only informal care received, only formal care received, and mixed care received (both informal care and formal care) (Carrino, 2015; Van Groenou and Glaser, 2006). In this study, I cannot capture mixed care because the CLHLS only collects information about the primary carer, making it impossible to establish whether individuals may receive a combination of both formal and informal care. However, this is unlikely to change the main results. Existing evidence suggests that both private and public formal care provision is still in the initial stage of development in China, therefore, mixed care is rare in most parts of the country, especially in rural and under-developed areas (Hu and Ma, 2018). (2) intensity of informal care, a continuous variable with logarithmic form, based on information on number of hours of care received from children/grandchildren last week.

Independent variables of interest: Household per capita income

Income refers to household per capita income of older people, which is a key variable in this study. It is introduced in detail in Section 5.3 of Chapter 5. The value of household per capita income in 2005, 2008, and 2011 is inflated to 2014 using Consumer Price Indexes. In all models, I use the logarithmic form of household per capita income to account for non-linearities (Iacobucci et al., 2016; Wooldridge, 2012).

Covariates

Some covariates are introduced in detail in Section 5.3 of Chapter 5. Based on the literature on informal care in China (Du and Wang, 2017; Hu and Ma, 2018; Peng et al., 2017), I also include some other variables, which might influence the receipt of informal care. Number of surviving children is an indicator for the number of surviving children the individual has. These two variables are included in the analysis because studies show that they influence the availability of informal care (Hu and Ma, 2018). The availability of financial assistance from children is based on whether the individual received financial assistance from children. This variable is included because it is a common practice in China. Adult children who migrate to

developed areas often provide financial assistance to older parents in rural areas, which may influence older people's socioeconomic status and preference for informal care (Hu and Ma, 2018). The availability of community care services is a binary variable indicating whether the individual lived in a community with social care service. Since access to community care services may satisfy older people's care need, reducing the utilisation of informal care, this variable is incorporated into analysis (Peng et al., 2017).

Empirical strategy

I first use Erreygers's Concentration Index (EI), Concentration Index (CI) and Horizontal Inequity Index (HI) to estimate the direction and degree of income-related inequalities in informal care in descriptive analysis. These indices are commonly applied indicators to measure the direction and degree of inequalities in care use (García-gómez et al., 2015; O'Donnell et al., 2007; Vincenzo et al., 2017). The method involves four steps: (1) estimating a model on the determinants of informal care receipt, using need and non-need variables; (2) calculating the unstandardised EI and CI; (3) using the sample mean for non-need variables, calculating need-adjusted EI and CI; and (4) estimating HI, showing inequalities in informal care only driven by socioeconomic factors. Because the first dependent variable, whether receiving informal care or not, is a categorical variable, I use EI, the corrected version of the concentration index for bounded variables suggested by Erreygers, to have a better estimation in inequalities in the percentage of receiving informal care (O'Donnell et al., 2007). Because the second dependent variable, intensity of informal care, is a continuous variable, I use CI to compare the cumulative distribution of hours in informal care received with the cumulative distribution of older people ranked by household per capita income, to estimate inequalities in intensity of informal care.

Specifically, I estimate the CI of informal care as follows:

$$CI = \frac{2}{\mu} cov(y_{it}, R_{it}) \qquad [6.1]$$

Where i represents the individual, t represents the year, μ represents the mean of the dependent variable in the total sample; y_{it} represents the dependent variable; and R_{it} represents the individual's rank within the income distribution in each year. If there are no income-related inequalities, the index is zero. A positive value means that there is a pro-rich inequality, e.g., hours of informal care are more concentrated among the high-income group,

while a negative value implies a pro-poor inequality, e.g., hours of informal care are more concentrated among the low-income group. The magnitude of the CI reflects the strength of the relationship between income and hours of informal care. For example, an index of 0.9 indicates that more hours of informal care are concentrated among those with higher income. Compared with an index of 0.1, an index of 0.9 indicates more pronounced pro-rich inequality for hours of informal care.

However, recent studies have suggested that there are some limitations on the CI. If the dependent variable of interest is categorical, then the bounds of the CI depend on the mean of the dependent variable. The bounds turn out to be wider for populations with a low mean (i.e. close to 0) than for populations with a high mean (i.e. close to 1) (Erreygers, 2009). Therefore, I use Erreygers's Concentration Index to measure the inequalities in whether receiving informal care or not as follows:

$$EI = \frac{4\mu}{(b_n - a_n)} CI \qquad [6.2]$$

Where b_n and a_n represent the maximum and minimum of the dependent variable of interest, μ is the mean of the health variable in the population, and CI represents the CI specified in equation [6.1]. The range of EI is from -1 to 1. A positive EI indicates a pro-rich inequality, meaning that the receipt of informal care is more concentrated among those with higher income, while a negative EI indicates a pro-poor inequality, meaning that the receipt of informal care is more concentrated among those with lower income.

It is noted that the inequalities CI and EI show are driven by both need factors and non-need/socioeconomic factors. Policy may be less concerned with inequalities arising from need factors, because these are usually reasonable and acceptable. A measurement of inequalities only driven by socioeconomic factors would be desirable for policy formation, therefore, the indirect method of standardisation is commonly used (O'Donnell et al., 2007). The whole process is as following. First, a model of the determinants of informal care receipt was estimated,

$$y_i = \alpha + \sum_k \beta_k N_{ki} + \sum_j \gamma_j Z_{ji} + \varepsilon_i \qquad [6.3]$$

where y_i represents the actual receipt of informal care, N_k represents a set of need-related factors, and Z_j represents a set of non-need factors, α, β, γ are the parameter vectors, ε is the error term.

The need-adjusted utilisation is then defined as follows:

$$\hat{y}_i = \hat{\alpha} + \sum_k \hat{\beta}_k N_{ki} + \sum_j \hat{\gamma}_j \bar{Z}_{ji} + \varepsilon_i \quad [6.4]$$

where $\hat{y}_i$ represents the predicted value of informal care receipt. As the equation shows, the actual values of need-related variables are used for standardisation, while the mean value of non-need factors are not to be standardised, but to be controlled for.

The indirectly standardised need-adjusted utilisation is calculated using the difference between actual use of informal care (y_i) and the predicted value of use of informal care ($\hat{y}_i$), adding the sample mean value of use of informal care $\bar{y}$, to find the distribution of use of informal care only associated with socioeconomic factors. Thus, a positive HI indicates pro-rich inequality, while a negative HI indicates pro-poor inequality, after controlling for need-related factors.

Longitudinal data model with random effects is then used to control for both time-invariant and time-variant variables to examine the relationship between household per capita income and informal care in inferential analysis. The model is as follows:

$$\mathrm{IFC_{it}} = \alpha_0 + \alpha_1 \ln\,(\mathrm{Income})_{\mathrm{it}} + \alpha_2 \mathrm{A_i} + \alpha_3 \mathrm{B_{it}} + \varepsilon_{\mathrm{it}} \quad [6.5]$$

where IFC_{it} represents whether receive informal care or not or hours of informal care the individual received from children/grandchildren last week. $\mathrm{A_i}$ represents time-invariant variables (gender and education). $\mathrm{B_{it}}$ represents time-variant variables (other covariates). The positive value of α_1 means that those with higher household per capita income may receive more informal care, while the negative value of α_1 means that those with lower household per capita income may receive more informal care.

To examine the heterogenous relationship between income, informal care and limitations, an interaction of income and number of ADL limitations is added to the model:

$$\mathrm{IFC_{it}} = \alpha_0 + \alpha_1 \ln\,(\mathrm{Income})_{\mathrm{it}} + \alpha_2 \ln\,(\mathrm{Income})_{\mathrm{it}} * \mathrm{Number\ of\ ADL\ limitations_{it}} + \alpha_3 \mathrm{Number\ of\ ADL\ limitations_{it}} + \alpha_4 \mathrm{A_i} + \alpha_5 \mathrm{B_{it}} + \varepsilon_{\mathrm{it}} \quad [6.6]$$

where a positive value for α_2 would imply that the more limitation the ADL, the greater the effect of income on informal care is, while a negative value for α_2 would imply that the more limitation the ADL, the less the effect of income on informal care is.

6.3 Results

Table 4 shows the proportion of respondents receiving informal care and the average number of informal care hours by income quintiles among older people with functional limitations. It presents that the probability of receiving informal care decreases as income increases. Among the total sample, 97.27% of those in the lowest income quintile reported receiving informal care, compared to 87.51% in the highest income quintile. The percentage of receiving informal care varies more by income quintile among those with three or more ADL limitations, from 97.14% to 85.11%, than among those with one or two ADL limitations. Focusing on informal care recipients, it provides different findings. The number of hours of informal care received increases as income increases, particularly for those with three or more ADL limitations. Among the total sample, those in the lowest income quintile receive an average of 43.54 hours of informal care per week, while those in the highest income quintile receive an average of 54.48 hours of informal care per week. The differences in weekly hours of informal care by income quintiles are much larger among those with three or more ADL limitations, from 55.51 to 71.99 hours, than among those with one or two ADL limitations, which range from 30.78 to 36.42 hours.

Table 5 summarises the results of the EI, CI and HI indices. EI indicates the level of inequalities in receiving informal care, CI indicates the level of inequalities in intensity of informal care among informal care recipients, HI indicates the level of inequalities driven only by individual's socioeconomic factors. Confidence intervals are calculated using bootstrapping methods. In terms of informal care receipt, the EI and HI indices are not significant at the 0.05 significant level. This indicates that there are no significant income-related inequalities in proportion of receiving informal care. However, both the CI and HI indices show the pro-rich inequality in intensity of informal care, and both values are significant at 0.05 significant level. This means that more hours of informal care are concentrated among older people with higher income. Furthermore, I compare these concentration indices between those with one or two ADL limitations and those with three or more ADL limitations. All indices for the receipt of informal care are not significant at the 0.05 significant level, which means that there are no significant income-related inequalities in informal care receipt among these two subgroups. However, by looking at the intensity of informal care, all indices are significant at the 0.05 significant level. The values of the CI and HI indices for those with three or more ADL limitations are 0.0206 and 0.0214, respectively,

much higher than those with one or two ADL limitations. This indicates that the extent of the pro-rich inequality in hours of informal care are much greater among those with higher level of functional limitations.

Table 4. Informal care receipt by income quintiles among older people with functional limitations

	Percentage of receiving informal care (%) [a]			Average number of informal care weekly hours (hours) [b]		
	Total	ADL<3	ADL>=3	Total	ADL<3	ADL>=3
Poorest	97.27 (N=2,258)	97.39 (N=1,128)	97.14 (N=1,130)	43.54	30.78	55.51
2nd poorest	94.44 (N=2,034)	95.14 (N=1,105)	94.72 (N=943)	46.23	32.03	62.34
Middle	92.74 (N=2,061)	94.32 (N=1,054)	91.15 (N=1,006)	48.66	33.60	63.33
2nd richest	92.10 (N=2,056)	92.25 (N=1,044)	91.94 (N=1,011)	54.66	38.44	71.00
Richest	87.51 (N=1,949)	89.83 (N=1,015)	85.11 (N=933)	54.48	36.42	71.99

Notes: [a] For the percentage of receiving informal care, the number of observations are 11,158 (Total), 5,699 (ADL<3), 5,459 (ADL>=3). Cells represent percentages (absolute number). ADL = activities of daily living. [b] Focusing on those receiving informal care, for average number of informal care weekly hours, the numbers of observations are 10,203 (Total), 5,100 (ADL<3), 5,103 (ADL>=3).

Table 5. Concentration indices in informal care receipt among older people with functional limitations

		Total	ADL<3	ADL>=3
Receiving Informal care	EI	-0.0090	0.0196	-0.0286
	Confidence Interval	(-0.025, 0.007)	(-0.011, 0.050)	(-0.040, -0.017)
	HI	-0.0043	0.0044	-0.0130
	Confidence Interval	(-0.011, 0.003)	(-0.009, 0.018)	(-0.018, -0.008)
Intensity of informal care	CI	0.0094 ***	0.0084 ***	0.0206 ***
	Confidence Interval	(0.008, 0.011)	(0.008, 0.009)	(0.012,0.030)
	HI	0.0119 ***	0.0039 ***	0.0214 ***
	Confidence Interval	(0.009, 0.015)	(0.003, 0.004)	(0.008, 0.035)

Notes: EI = Erreygers's Concentration Index, CI = Concentration Index, and HI = Horizontal Inequity Index, ADL = activities of daily living. *** p<0.01, ** p<0.05, * p<0.1.

Table 6 presents the results of random effects multinomial logistic regression models to show the relationship between household per capita income and LTC use. Model 1 and 2 are the results of the relationship between income and receiving informal care, the reference category is receiving no care. There is no evidence that income is a significant factor in Model 1, which indicates that there is no significant relationship between income and informal care receipt, echoing findings from concentration indices in Table 5. Model 2 shows that there is no significant interaction between income and number of ADL limitations, suggesting that the relationship between income and informal care receipt does not significantly differ by number of ADL limitations. Model 3 and 4 are the results of the relationship between income and using formal care, the reference category is receiving no care. I find a significantly positive association between income and using formal care in Model 3, which means that with a one-unit increase in income, the individual will have 59% increase in the probability of using formal care (OR=1.590, p<0.01). Model 4 reports a positive interaction between income and number of ADL limitations (OR=2.655, p<0.01), indicating that with additional increase in number of ADL limitation, one unit increase in income translates to 166% additional increase in probability of using formal care.

Focusing on informal care recipients, Table 7 provides the results of random effects linear regression models to show the relationship between income and hours of informal care received from children/grandchildren. Consistent with results in Table 6-3, Models 1 shows that higher income is significantly associated with more hours of informal care received (β=0.019, p<0.05). All other things being equal, an additional unit increase in income is associated with 0.019 unit increase in hours of informal care received. Models 2 shows a significantly positive interaction between income and number of ADL limitations (β=0.017, p<0.01). With additional increase in number of ADL limitation, one unit increase in income translates to 0.017 additional unit increase in hours of informal care received. In other words, the more limitation the individual has, the greater the positive effect of income on hours of informal care, the greater the difference in hours of care from children/grandchildren between higher and lower income groups.

Robustness check

I perform two sets of robustness check (see Appendix A). In the first robustness check, I replace the number of ADL limitations with a binary variable that indicates whether the

individual has three or more ADL limitations, which is consistent with other literature (Mor et al., 1994; Shen et al., 2015). It is widely agreed that if the individual reported need for help with or inability to perform three or more ADLs, he/she is severely impaired in daily life. In addition, the report of three or more ADL limitations is of particular interest in LTC research because this level of limitation is often used in many countries to determine whether an older person is eligible for receiving formal LTC (Dunlop et al., 2002). Therefore, I use this binary variable. As Appendix A1 shows, income is not significantly associated with receiving informal care (OR=0.979, p>0.1). Appendix A2 shows that those with higher income are more likely to receive more hours of informal care (β=0.020, p<0.05). There is also a significantly positive interaction between income and this binary variable. For those with three or more ADL limitations, an increase in income is significantly associated with a higher increase in number of hours of informal care received (β=0.068, p<0.01). Following previous studies, the second robustness check adds having medical insurance into analysis. Having medical insurance is a binary variable with 'no' set as the reference category. As Appendix A3 and A4 show, income does not have significant association with receiving informal care (OR=0.970, p>0.1), but among those receiving informal care, there is a pro-rich inequality in the intensity of informal care (β=0.020, p<0.05), this pro-rich inequality is significant associated with number of ADL limitations (β=0.016, p<0.01).

Table 6. Random effects multinomial logistic regression models among older people with functional limitations

	Receiving informal care		Receiving formal care	
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
LN (income)	0.979 (0.064)	1.062 (0.107)	1.590 (0.126) ***	1.720 (0.189) ***
Limitations in ADLs	2.049 (0.241) ***	2.084 (0.254) ***	2.620 (0.317) ***	2.655 (0.333) ***
LN (income) * limitations in ADLs		1.055 (0.058)		1.062 (0.062)
Need-related variables				
Age	1.049 (0.013) ***	1.049 (0.013) ***	1.072 (0.015) ***	1.072 (0.015) ***
Male	1.393 (0.305)	1.392 (0.305)	1.225 (0.299)	1.225 (0.298)
Self-rated health				
Bad	Ref	Ref	Ref	Ref
Fair	1.045 (0.263)	1.046 (0.264)	0.900 (0.252)	0.902 (0.253)
Good	1.152 (0.307)	1.161 (0.309)	1.073 (0.316)	1.081 (0.318)
Number of chronic diseases	1.111 (0.081)	1.112 (0.081)	1.145 (0.088) *	1.146 (0.088) *
Cognitive function scores	0.986 (0.012)	0.985 (0.012)	1.003 (0.014)	1.003 (0.014)
Non-need variables				
Education attainment				
No education	Ref	Ref	Ref	Ref
Elementary school	1.191 (0.364)	1.194 (0.365)	1.729 (0.563) *	1.735 (0.566) *
Middle school and above	1.438 (1.046)	1.442 (1.049)	3.998 (2.973) *	4.012 (2.984) *
Marital status				
Married	Ref	Ref	Ref	Ref
Widowed	1.276 (0.357)	1.272 (0.355)	0.235 (0.041) ***	0.235 (0.041) ***
Other	0.308 (0.154) **	0.304 (0.152) **	0.463 (0.118) ***	0.462 (0.118) ***
Place of residence				
City	Ref	Ref	Ref	Ref
Town	1.437 (0.437)	1.441 (0.439)	0.632 (0.206)	0.634 (0.207)
Rural	1.000 (0.240)	1.000 (0.241)	0.135 (0.037) ***	0.135 (0.037) ***
Co-residence with family members				
No	Ref	Ref	Ref	Ref

Yes	2.539 (0.651) ***	2.516 (0.646) ***	0.882 (0.259)	0.872 (0.256) ***
Number of surviving children	1.010 (0.052)	1.010 (0.052)	1.029 (0.058)	1.029 (0.058)
Financial assistance from children				
No	Ref	Ref	Ref	Ref
Yes	1.064 (0.284)	1.055 (0.282)	1.419 (0.419)	1. 408 (0.416)
Living in the community with care services				
No	Ref	Ref	Ref	Ref
Yes	0.992 (0.251)	0.991 (0.251)	1.284 (0.354)	1.283 (0.354) **
Year				
2005	Ref	Ref	Ref	Ref
2008	1.077 (0.279)	1.081 (0.279)	0.512 (0.145) **	0.513 (0.146) **
2011	1.075 (0.305)	1.079 (0.307)	0.370 (0.118) ***	0.371 (0.118) ***
2014	1.086 (0.364)	1.094 (0.367)	0.191 (0.075) ***	0.192 (0.076) ***
_cons	0.081 (0.107)	0.146 (0.216)	0.000 (0.000) ***	0.000 (0.000) ***
N	11,158	11,158	11,158	11,158

Notes: Ref=reference. ADL = activities of daily living. *** p<0.01, ** p<0.05, * p<0.1. Model 1 and 2 are results of receiving informal care from random effects multinomial logistic regression models. The reference category is receiving no care. Model 3 and 4 are results of receiving formal care from random effects multinomial logistic regression models. The reference category is receiving no care. Cells represent odds ratio (standard error).

Table 7. Random effects linear regression models among informal care recipients

	Intensity of Informal care	
Variables	**Model 1**	**Model 2**
LN (income)	0.019 (0.009) **	0.018 (0.009) **
Limitations in ADLs	0.237 (0.007) ***	0.239 (0.007) ***
LN (income) * limitations in ADLs		0.017 (0.004) ***
Need-related variables		
Age	0.011 (0.002) ***	0.010 (0.002) ***
Male	-0.017 (0.029)	-0.016 (0.029)
Self-rated health		
Bad	Ref	Ref
Fair	0.002 (0.033)	0.004 (0.033)
Good	0.029 (0.035)	0.032 (0.035)
Number of chronic diseases	0.029 (0.009) ***	0.029 (0.009) ***
Cognitive function scores	-0.009 (0.001) ***	-0.009 (0.001) ***
Non-need variables		
Education attainment		
No education	Ref	Ref
Elementary school	-0.050 (0.039)	-0.048 (0.039)
Middle school and above	0.007 (0.082)	0.012 (0.082)
Marital status		
Married	Ref	Ref
Widowed	0.235 (0.041) ***	0.235 (0.041) ***
Other	0.463 (0.118) ***	0.462 (0.118) ***
Place of residence		
City	Ref	Ref
Town	-0.334 (0.037) ***	-0.334 (0.037) ***
Rural	-0.281 (0.032) ***	-0.282 (0.032) ***
Co-residence with family members		
No	Ref	Ref
Yes	0.199 (0.050) ***	0.191 (0.050) ***

Number of surviving children	0.007 (0.007)	0.007 (0.006)
Financial assistance from children		
No	Ref	Ref
Yes	0.023 (0.035)	0.025 (0.035)
Living in the community with care services		
No	Ref	Ref
Yes	-0.060 (0.032) *	-0.060 (0.032) *
Year		
2005	Ref	Ref
2008	0.072 (0.033) **	0.075 (0.033) **
2011	-0.017 (0.039)	-0.015 (0.039)
2014	0.009 (0.046)	0.011 (0.046)
_cons	2.168 (0.179) ***	2.173 (0.179) ***
N	10,203	10,203

Notes: Ref=reference. ADL = activities of daily living. *** p<0.01, ** p<0.05, * p<0.1. Model 1 and 2 are results of random effects linear regression models. Cells represent coefficient (standard error).

6.4 Discussion

This study examines income-related inequalities in informal care using a nationally representative sample in China. I find that there are no significant income-related inequalities in the probability of receiving informal care (at the extensive margin), but among those receiving informal care, there is a pro-rich inequality in the intensity of informal care (at the intensive margin). In other words, higher household per capita income is significantly associated with higher intensity of informal care. The pro-rich inequality in the intensity of informal care significantly increases as the number of ADL limitations increases.

The findings that there are no significant inequalities in the probability of receiving informal care are consistent with some studies in China (Hu and Ma, 2018), but are not in line with some studies in developed countries, showing that there are pro-poor inequalities in receiving informal care (García-gómez et al., 2015). One possible explanation is that formal care services are underdeveloped in China. In some European countries, where formal care is well-developed, high-income groups have the option of substituting formal care for informal care. When they receive formal care, their health needs are met, which may reduce their reliance on family members (Van Houtven and Norton, 2004). This is not the case in China. Although Table 6 shows that high-income groups are more likely to use paid care/formal care services, these services are limited and unbalanced in most parts of the country. Some studies show that even though high-income groups can afford them, some do not have access to them (Hu, 2020). In this case, family members serve as the primary safety net to meet the need of people regardless of income in China.

The findings on pro-rich inequality in hours of informal care is consistent with previous studies on intergenerational relationships in China (An, 2019; Liu, 2015; Yan and Xue, 2018) as well as predictions from the collective model (Alderman et al, 1995). Using logistic regression model with cross-sectional data, they show the similar findings, that is, older people with higher socioeconomic status are more likely to receive more support from their children. They explain that during the process of modernisation, the motivation of adult children providing care for older parents is complicated, including both altruism and exchange motivations. They care for older parents in expectation of both parents' better health and the exchange for other benefits. The collective model is a common theoretical framework used to explain intergenerational support. This model proposes that each family

member has different amounts of ‘bargaining power’ relative to others in the family. The relative bargaining power of each family member guides his/her interactions and is reflected in the family’s allocation of resources (Chiappori, 1992). With rapid modernisation, the traditional value of filial piety has been challenged, the parental power of older parents in the traditional family has been reduced. Thus, the bargaining power of older parents in the family has also been challenged, and the unconditional willingness of adult children to care for older parents has declined (Cong and Silverstein, 2012). Increasingly, older parents rely on their socioeconomic resources to influence adult children’s caregiving decisions, by providing downward transfers in exchange for receiving informal care (Lloyd-Sherlock et al., 2018). For example, older parents with higher income are more likely to give money or gifts to adult children in exchange for receiving more informal care (An, 2019). Meanwhile, given the expectation of future transfer, such as bequests, adult children may provide more care for older parents with higher income (Liu, 2015). Furthermore, caring for older parents who have more ADL limitations places a greater burden on carers (Saraceno, 2010). Those with lower income but more ADL limitations have less future bequest in exchange for care, but greater need for around-the-clock care. When faced with fewer benefits but more demanding requests, adult children's willingness to provide care decreases. As a result, low-income older people with more ADL limitations have less bargaining power, making it less likely that they receive care from family members.

Findings from this study have important implications for LTC system policies in China. The association between income and informal care receipt among older people is not significant. This suggests that because formal care is in its infancy, informal care is the only option for older people, no matter they are rich or poor. However, this may lead to some concerns. Informal care is normally considered to be unskilled care, where family members often lack professional knowledge and skills (Van Groenou and Boer, 2016; Vincenzo Carrieri et al., 2017). A recent study in China indicates that older people with functional limitations have complex need that requires specialised care by professional carers, but informal care is unable to fulfil their need (Yang and Tan, 2019). The lack of professional care for a long time may be harmful for their health in the long run. As a result, there is an urgent need for the government to improve the capacity of formal care provision. In European countries, many governments are adopting a mixed provision of the formal and informal care to provide collaboration between professional carers and family members. For example, rehabilitation therapists and social workers in the community play an important role in supporting informal

carers in order to improve the quality of care (Van Groenou and Boer, 2016). Similar measures should be adopted by the Chinese government to address the complex LTC need of older people.

Among those receiving informal care, low-income individuals are less likely to receive intensive informal care. This implies that there is a pressing need for policymakers and practitioners to buttress the formal care delivery systems to low-income groups to make up for the lack of intensive informal care. There is currently a great divide in availability of formal care in China: formal care services has developed greatly in provincial capitals or large cities, while formal care services remain scarce in poor rural and town areas (Jia et al., 2014). Because low-income older people, especially those in poor areas, do not have access to either intensive informal or formal care, their health may deteriorate (An, 2019). LTC policies should therefore prioritise programmes that provide accessible intensive formal care targeted to low-income households.

In addition, it is important to increase low-income individuals' financial capability in order to make formal care services more affordable. In many European countries, such as Germany, the government provides cash allowance to low-income groups (Campbell et al. , 2010; Roit and Bihan, 2010). In Japan and Korea, eligible people could receive facility benefits, in-home benefits, assistive device benefits, and special cash benefit (Rhee et al., 2015). The governments in Nanjing and Tianjin in China have started to implement similar policies, providing vouchers or cash-for-care benefits to low-income groups. However, in some areas, limited subsidies are only available for those living below the poverty line with severe impairments, resulting in the absence of formal care for many low-income individuals (Du and Ji, 2019). As a result, more steps should be taken to relax the eligibility restrictions on government support.

Furthermore, a more comprehensive LTCI system should be developed at the national level as a safety net (Du, 2015). China has piloted LTCI programs in Qingdao since 2012, but studies show that the low-income group are more likely to encounter access barriers or incur high out-of-pocket expenses because of their low reimbursement rate (Yang et al., 2020). Thus, the LTCI system should be tailored to the low-income groups who are at risk of incurring higher-than-expected costs, for example, by increasing reimbursement rates and

expanding service coverage. More steps should be taken to improve the disadvantaged groups' access to formal care services in order to ensure equity in LTC.

Some limitations in this study should be considered. First, there is no information on hours of care received from spouse, siblings and other family members in the CLHLS, which may be important in understanding inequalities in the receipt of informal care. Further information is needed to have a further understanding of inequalities in source of informal care. Second, this study assumes that individuals receive either informal care only or formal care only. Since the question in this survey is about the primary carer, the respondents have only one choice, it is unable to identify those receiving both informal and formal care. However, this is not a major concern, as prior evidence suggests that the proportion of older people receiving mixed care is very small (Hu and Ma, 2018). Third, this study does not take the type of "time-for-money" exchange into consideration. Studies show that some grandparents in rural areas provide care to their grandchildren, in return, their adult children send them remittances or provide needed care for them (Cong and Silverstein, 2008b). However, this may not be a major concern, since this study focuses on older people with functional limitations, whose functional health may prevent them from caring for grandchildren. It would be interesting to include the care for grandchildren into further analysis if such information is available in the datasets. Lastly, while this study demonstrates the magnitude of inequalities, future research is needed to examine the causal mechanisms underlying associations observed. This study provides a basic understanding of the distribution of informal care across different income groups, assuming that income has a one-way causal impact on informal care receipt. Other quantitative methods can be considered to reduce reverse causality bias.

Chapter 7. Protective effects of informal care receipt on health of older people

Does receiving informal care lead to better health outcomes? Evidence from Chinese Longitudinal Healthy Longevity Survey[2]

Abstract

Population ageing has become a global challenge. Drawing data from Chinese Longitudinal Healthy Longevity Survey 2008, 2011 and 2014, this study examines the effect of informal care receipt on functional limitations and depressive symptoms among older people in China using lagged fixed effects model. The findings suggest that receiving informal care is significantly associated with a slower functional decline. I also find that this effect varies across different income groups. The protective effect of informal care is more pronounced among older people with higher income compared to those with lower income. I do not observe any significant associations between receiving informal care and depressive symptoms of older people. This study highlights a pressing need for the Chinese government to establish a comprehensive long-term care system.

[2] This chapter is based upon a published co-authored paper (with Dr. Wei Yang) in Research on Aging (Wang and Yang, 2021).

7.1 Introduction

LTC is important for older people who have difficulties in performing basic activities of daily living (Hu and Li, 2018). Informal care (i.e., unpaid care in daily activities provided to older people by spouse, children, grandchildren, other relatives, neighbours or friends), is the most common form of LTC in both developed and developing countries (Wang et al., 2021). In European countries, it is estimated that between 20% to 44% of LTC is provided by informal carers (Jang et al., 2012). In China, LTC provision is largely reliant on informal carers, and the proportion of informal care as accounted for total LTC provision can be as high as 90% (Du, 2015).

A growing body of studies have examined the effects of receiving informal care on people's health. Some researchers find that receiving help during bathing, indoor transferring, and toileting could prevent older people from accidents, receiving help in feeding could help them have a better diet and have sufficient nutrition, receiving help in taking medicine could help them better manage their health conditions (Desai et al., 2001). Receiving informal care and support, therefore, can protect older people against a downward spiral in their functional capabilities (Hu and Li, 2018). Informal care also provides a sense of meaningful, belonging and companionship, reducing risks of stress, loneliness, and depression (Ji and Sun, 2018), increasing the level of life satisfaction (Wang and Li, 2011b). In contrast, others point out that receiving informal care may not always be associated with better health outcomes. Caring for older people with functional limitations for a long time strains the time, finances, and health of many family carers, making the relationship between carers and care recipients more strained, leading to negative consequences on older people's health (Lin and Wu, 2011). When some individuals have to rely on other people's help to perform everyday tasks, they may feel that they are a burden to carers. This negative feeling may also impact their physical and mental health (Wang and Li, 2011a; Wu and Mok, 2007).

It should be noted that informal care is a type of social support embedded in specific cultural context. People from different cultural backgrounds may value informal care differently. Specifically, independence is socially and culturally valued among older people in Western countries, stressing the importance of mastery on their own. Relying on others reduces a sense of independence, resulting in negative consequences for health (Lin and Wu, 2011). However, in most East Asian societies where Confucianism ideology is the predominant

value, older people place more emphasis on role of parents positioning in family than on independence. They are proud of receiving care from families and feel fortunate that they can depend on family members to provide care. The sense of life satisfaction and happiness may be far greater than the depression caused by loss of independence (Hu and Li, 2018). Thus, the research findings in Western countries may not be generalised to another with a different context.

Although informal care is highly valued in many East Asian societies, studies find that this tradition is challenged by recent demographic and social transitions (Cong and Silverstein, 2008b). During the process of modernisation, some adult children from rural areas move to urban areas for economic necessity, the long distance between them and their older parents creates more barriers for them to provide day-to-day care. Further, a great number of females are participating in the labour market, which means that they have difficulties in providing longer hours of care to their older parents or relatives. An increase in the hours of care may seriously disrupt their daily routines, crowd out their time to fulfil other responsibilities in life, such as work or social activities, making them feel stressed. Such negative influence may affect the quality of care and impair their relationship with care recipients.

Studies also find that care outcomes may vary across older people with different socioeconomic status. In modern society, adult children may expect future monetary transfer such as bequest in exchange of providing care. Older people with lower income may have less savings or assets for such an exchange, therefore, as Chapter 6 shows, they receive less care from adult children, compared to those with higher income. Moreover, informal carers from lower socioeconomic groups often have fewer learning opportunities and limited knowledge in care provision (Pampel et al., 2011). They are less likely to encourage older people to have a healthy diet and lifestyle in a proper way, which is important for better health outcomes. On the contrary, informal carers from higher socioeconomic groups have sufficient resources, information as well as knowledge in promoting health. They are more likely to persuade older people to adopt positive health practices in an appropriate way, leading to better health outcomes.

Against this backdrop, this study seeks to examine the effect of informal care on health of older people in China using 2008, 2011 and 2014 waves of the CLHLS. Specifically, I ask the following research questions (RQ):

RQ1: What effect does informal care have on older people's health trajectories over time?
RQ2: Among those receiving informal care, do longer care hours lead to better health outcomes for older people?
RQ3: Do these relationships vary across different income groups?

Conceptual framework

As Chapter 3 Section 3.4 discussed, this analysis is based on stress buffering model which is widely used to explain the relationship between informal care and health outcomes of older people (Cohen and Wills, 1994; Suanet et al., 2020; Thoits, 2011). Older people with functional limitations are likely to be stressed due to their circumstances. The model suggests that informal care can act as a buffer or coping strategy for older people when they receive help from spouse, adult children, other relatives and friends (Cohen and Wills, 1994). Influenced by informal carers, older people tend to be more conscious of their lifestyle and health behaviour. They often change their own behaviours to match the expectations of the informal carers, such as giving up smoking, participating in physical exercises, and adhere to their prescription (Thoits, 2011). If they have health-damaging health behaviours or health problems, informal carers may tell or remind older people to seek health advice, engage in healthy behaviours, or avoid taking risks. For example, those receive informal care are more likely to have a healthy and nutritious diet compared to those without any care as informal carers are often in charge of meal preparation (Uchino, 2004b).

Informal care can have significant effects on older people's mental health. The stress-buffering model suggests that the perception that others can provide help with daily tasks may redefine the potential stress posed by decline in health, bolster older people's perceived ability to cope with daily activities, sustains confidence in their ability in face of challenges, and prevent psychological distress and depression (Cohen and Pressman, 2004). The lack of informal care receipt would increase older people's appraisals of stress caused by inability of performing daily activities, resulting in feelings of helplessness, anxiety, and depression. Moreover, the receipt of informal care also produces positive effects on mental health by companionship. Although this study focuses on support relating to help with preforming basic daily activities rather than emotional support, these two types of support are usually related (Cohen and Wills, 1994). Spending more time with carers who are close to them, older people's need for social and family interaction can be met, which distracts them from

worrying about their own health, resulting in less stress. Informal care can also provide a sense of belonging. Receiving informal care implies acceptance by one's family members, relatives, friends and others, whom individuals are emotionally tied to and whom they view as important or influential in their lives (Cobb, 1976). By contrast, without assistance in daily life, older people tend to feel more threatened because they lack the coping resources to successfully adjust to functional limitations, increasing feelings of loneliness, stress and depression.

The stress buffering model explains why informal care may help to improve older people's health outcomes, but evidence from the literature is not consistent. Some researchers suggest that informal care receipt may be linked to negative processes, such as feelings of dependence or becoming a burden (Uchino et al., 2016). Older people may find themselves have poor competence in daily life and have to rely on others. Thus, they may have lower self-confidence and self-esteem. These negative consequences may impair the relationship between older people and their carers, reduce the quality of care, and ultimately contribute to poor health outcomes.

The mixed evidence from the literature highlights the importance of the sociocultural context where informal care is influenced and shaped. In Western countries, people are influenced by a more individualistic culture, where the main goal of the development is to be relatively independent. Receiving informal care may reduce the independence of older people and their autonomy. Some of them even regard informal care as unhelpful assistance and are not willing to accept it (Bai et al., 2016). In contrast, in many East Asian cultures which are strongly influenced by familism and filial piety, family members are striving to fulfil filial obligations, and older people place a higher value on the role of parents in the family than they do on their own sense of independence. Thus, I hypothesise that informal care will have positive effects on older people's health in the context of China. This leads to the first hypothesis (H):

> H1: Receiving informal care is associated with a slower decline in functional and mental health among older people in China.

Focusing on care recipients, the relationship between intensity of care and health outcomes is not clear from the literature. In China, due to urbanisation and migration over the past few

decades, many adult children have moved to urban areas for economic reasons, leaving their older parents behind. Providing longer hours of care may lead to interruptions at work, loss or reduced productivity, as well as limited leisure time (Cook and Dong, 2011). These difficulties may contribute to physical and mental health issues, affect the quality of informal care, interfere with the buffering effects of informal care (Reinhard et al., 2008). Therefore, the second hypothesis is summarised as follows:

H2: Increased hours of informal care may not always lead to better health outcomes.

The role of informal care as stress buffer may vary across different income groups (Krause and Borawski-Clark, 1995). Compared with those with higher income, older people with lower income are more likely to experience worse health status. This indicates that they have already been more disadvantaged in health. Even if they receive same amount and quality of care, their health improvement might not be noticeable. In general, low-income older people have limited financial resources to compensate informal carers in exchange for care. Therefore, they may receive less care from their children, compared to those with higher income. Without sufficient financial compensation, informal carers may feel stressed and burdened by older people, which will affect the amount and quality of care and consequently health outcomes of the older people. Moreover, in this study, it is assumed that family carers and care recipients share similar levels of socioeconomic status. For low-income older people, their family carers may have limited resources, lack the knowledge of health-promoting information, and face more stressful events, such as unemployment and financial loss. Crowding out time to provide care makes them feel overburdened, not to mention persuading older people to engage in health-enhancing behaviours in a proper way (Thoits, 2011). By contrast, for high-income older people, their family carers may have more resource, face fewer stressful events and are more likely to help them develop health-promoting behaviours in an appropriate way, which is good for health outcomes. The third hypothesis is formulated as follows:

H3: The effects of informal care on health outcomes are more pronounced among older people with higher income, compared those with lower income.

7.2 Data and Methods

Data and sample

Individual-level data are drawn from the 2008, 2011, and 2014 waves of the CLHLS. Although the CLHLS started to collect information on informal care from 2005, the number of survivors in all of the 2005, 2008, 2011, and 2014 waves is limited, the number of survivors in both of the 2014 and 2018 waves is also limited. Thus, the study sample encompasses older people aged 65 and above who survived in all of the 2008, 2011, and 2014 waves. In the CLHLS, question on informal care is independent of question on care in nursing homes. Respondents are asked whether they live in nursing homes. No matter whether they live in nursing home or not, they are also asked to choose their primary carer from the following choices: spouse, children, grandchildren, other relatives, friends, neighbours, social services, or housekeepers. Although some nursing home residents receive informal care at the same time, it is unable to differentiate the effect of informal care from the effect of nursing home care on health outcomes. Therefore, I exclude individuals who lived in nursing homes (N=114) from the sample to reduce the potential bias to our findings. Moreover, because formal home- and community-based care is in the initial stage of development in China, number of individuals using formal home- and community-based LTC as the primary source of care is too small to do statistical analysis (N=81). I exclude these individuals to solely focus on the effect of informal care. The final sample size of this analysis is 4,396. Table 8 shows the descriptive statistics of the study sample.

Table 8. Descriptive characteristics of the sample

Variables	Mean (SD)/Percentages
Receiving informal care	
No	61.62 (N=2,709)
Yes	38.38 (N=1,687)
Weekly hours of informal care	3.209 (1.276)
Number of ADL limitations	0.377 (1.140)
Depressive symptoms	11.352 (3.330)
Age	
65-79	44.92
80+	55.08
Gender	
Female	53.88
Male	46.20
Education attainment	
No education	80.66
Elementary school	16.56
Middle school and above	2.78

Marital status	
Others	3.02
Widowed	52.27
Married	44.72
Place of residence	
City	16.36
Town	30.40
Rural	53.25
Living with family members	
No	17.60
Yes	82.40
Household per capita income (Yuan)	10921.96 (14933.49)
Smoking	
No	79.80
Yes	20.20
Drinking	
No	81.73
Yes	18.27
Self-rated Health	
Poor	18.70
Fair	35.06
Good	46.23
Number of chronic diseases	1.151 (1.317)
Cognitive function score	24.628 (7.295)
N	4,396

Notes: The unit of this study sample is the individual. Mean (SD) is presented for continuous variables, and Percentages is presented for categorical variables. ADL= activities of daily living. For the weekly hours of informal care, the number of the total sample is 1,685.

Variable specification

Dependent variable: Functional limitations, Depressive symptoms

The outcomes of interest are functional limitations and depressive symptoms. Functional limitations is captured by number of ADL limitations. In the CLHLS, there were six indicators assessing an individual's functional limitations, i.e., eating, dressing, indoor mobility, bathing, toileting, and continence. Number of ADL limitation is measured based on the number of these activities the individual is unable to perform or experience some difficulties with.

Five items are used to indicate depressive symptoms in existing studies based on CLHLS data. Out of the five questions, two measured positive feelings, i.e., 'Do you look on the bright side of things?' and 'Are you as happy now as when you were younger?', and the other three measured negative feelings, i.e., 'Do you often feel anxious or fearful?', 'Do you often

feel lonely and isolated?', and 'Do you feel the older you get the more useless you are?'. The respondents are asked to choose from five answers of 'Always', 'Often', 'Sometimes', 'Seldom' and 'Never'. A score from 1 to 5 was assigned to each answer, with a higher score indicating the higher level of feeling negative. Therefore, the summed score ranged from 5 to 25, with higher value indicating being more depressed. The validity and reliability of this measure has been carefully tested and verified in existing literature (Shen et al., 2019; Sun et al., 2021)

Independent variable: Informal care

In the CLHLS, respondents are first asked whether they required assistance in carrying out each activity of daily living, including bathing, dressing, toileting, indoor transferring, continence, and eating; if they report that they did, they are then asked to choose their primary carer. If they report that they primarily rely on informal carers (i.e., spouse, children, grandchildren, other relatives, friends or neighbours), they are then asked about the total number of hours they received help from children/grandchildren in the last week. Thus, two key independent variables of interest are used in this study. The first independent variable of interest is a binary variable which records a value of 1 if an individual receives informal care as the primary source of care and a value of 0 if an individual does not receive any care. Focusing on those primarily rely on informal care, the second variable, intensity of informal care, is constructed based on number of hours of informal care received from children/grandchildren last week. In all models, I use the logarithmic form of this continuous variable to account for non-linearities (Wooldridge, 2012).

In descriptive analysis, following existing studies (Hu and Li, 2018; Robards et al., 2015), I used 20 hours of informal care per week to measure the intensity of informal care and separated care recipients into those not receiving intensive informal care and those receiving intensive informal care. Individual receiving 20 hours and above informal care per week means that he/she receives intensive informal care.

Covariates

Household per capita income is not treated simply as control variables, but used to find whether the effects of informal care on health differs according to income. It is introduced in detail in Section 5.3 of Chapter 5. The value of household per capita income in 2008, and 2011 is inflated to 2014 using Consumer Price Indexes. In all models, I use the logarithmic

form of household per capita income to account for non-linearities (Iacobucci et al., 2016; Wooldridge, 2012).

Based on the stress-buffering model and existing studies, a set of need-related variables and non-need variables are controlled in the analysis (Hu and Li, 2018; Lin and Wu, 2011). Some covariates are introduced in detail in Section 5.3 of Chapter 5. Since lifestyle may influence health outcomes, I also include smoking and drinking into analysis, based on the questions 'Do you smoke at the present time?' and 'Do you drink alcohol at the present time?'. Smoking and drinking are binary variables with 'no' set as the reference category.

Empirical strategy

Fixed-effects (FE) model has been advocated as a useful approach to exploit the longitudinal nature of the data by assessing the association between changes in the explanatory variable and changes in the outcome variable within individuals (Wooldridge, 2012). In this study, it is used to examine the effect of within-individual changes in informal care on within-individual changes in health. Specifically, FE model uses each individual as his/her own control, by comparing his/her health outcomes when exposed to a given level of informal care receipt with that his/her health outcomes when he/she is exposed to a different level of informal care receipt. Assuming that within-individual changes in exposure are uncorrelated with changes in other variables, the difference in health outcomes between these waves is an estimate of the association between informal care receipt and health outcomes for that individual (Allison, 2006).

Existing studies which examine the relationship between informal care and health have recognised reverse causal effects of health on care, that is, poor health may influence the receipt of informal care (Lin and Wu, 2011). For the main FE model, it is possible that health decline may lead to higher possibility of receiving more informal care. In other words, the effect of informal care on functional decline may not be fully captured by this model due to the issue of reverse causality. Following the previous studies (Hu and Li, 2018; Lin and Wu, 2011), I use the lagged FE model to control the health status of the individual at the previous wave, and use the informal care variable at the previous wave to predict the health status of the individual at the following wave. Specifically, I use lagged informal care variable to examine whether changes in informal care receipt between waves 1 and 2 are associated with

changes in health outcomes between waves 2 and 3, to minimise the potential impact of reverse causality. The specification of the model is as below:

$$Health_{it} = \alpha_0 + \alpha_1 IFC_{i,t-1} + \beta_1 Health_{i,t-1} + \beta_2 X_{i,t-1} + \delta_i + \varepsilon_{it},\ t = 2, 3 \qquad [7.1]$$

where $Health_{it}$ denotes number of ADL limitations or depressive symptoms for an individual i at time point t. IFC_{it-1} denotes whether receiving informal care as the primary source of care or hours of informal care for an individual i at time point $t-1$. α_1 denotes the relationship between informal care and health. A positive value for α_1 indicates that informal care increases the likelihood of more ADL limitations or more depressive symptoms. A negative value for α_1 indicates that the protective effects of informal care on health, i.e., decreasing the likelihood of more ADL limitations or more depressive symptoms. X_{it-1} denotes all other independent variables for an individual i at time point $t-1$. δ_i denotes the individual-level unobserved heterogeneity.

To examine whether household per capita income modifies the relationship between informal care and health, an interaction between informal care and household per capita income is added to the model as following:

$$Health_{it} = \alpha_0 + \alpha_1 IFC_{i,t-1} + \gamma_1 IFC_{i,t-1} * \ln\left(Income_{i,t-1}\right) + \beta_1 Health_{i,t-1} + \beta_2 X_{i,t-1} + \delta_i + \varepsilon_{it},\quad t = 2, 3 \qquad [7.2]$$

where the value of γ_1 denotes the heterogenous effect of informal care on health across different income. A positive value for γ_1 would imply that the more income the individual has, the greater the effect of informal care receipt on health is, while a negative value for γ_1 would imply that the more income the individual has, the less the effect of informal care receipt on health is.

7.3 Results

Table 9 compares changes in health outcomes, i.e., functional limitations and depressive symptoms from the previous wave to the following wave among older people with and without informal care. In terms of functional limitations, column 3 and 4 show mean number of ADL limitations in the previous wave and the following wave, respectively. Column 5 shows the difference in mean number of ADL limitations from the previous wave to the following wave. For those without care, mean number of ADL limitations increases by 0.318 from the previous wave to the following wave; for those receiving informal care, mean

number of ADL limitations increases by 0.145 from the previous wave to the following wave. The results of t-test in column 6 show that those who receive informal care significantly develop fewer ADL limitations over time, compared to those who do not receive any informal care. In particular, those who do not receive any informal care significantly develop on average 0.172 more ADL limitations (ρ<0.01) between study waves, compared to those who receive some informal care. However, when focusing on those receiving informal care, the results seem to be different. Compared to those who receive intensive informal care, those who do not receive intensive informal care develop on average 0.12 more ADL limitations over time, but this is not significant at the significance level of 0.05.

I observe similar trends for depressive symptoms. Compared to those who do not receive care, those who receive informal care significantly develop on average 0.544 (ρ<0.01) fewer depressive symptoms between study waves. Among those receiving informal care, the changes in depressive symptoms between study waves are not significantly different between those not receiving intensive informal care and those receiving intensive informal care (ρ>0.1).

Table 9. Changes in health from wave t-1 to wave t for among older people with different status of care receipt in wave t-1

		Wave t-1	Wave t	Difference	*t*-stat
Mean number of ADL limitations	(1) Receiving no care	0.012	0.330	0.318	27.452 ***
	(2) Receiving informal care	1.724	1.869	0.145	2.260 **
	Difference (1) – (2)			0.172	2.633 ***
	(3) Not receiving intensive informal care	0.256	0.628	0.372	13.648 ***
	(4) Receiving intensive informal care	1.459	1.710	0.252	3.477 ***
	Difference (3) – (4)			0.120	1.554 *
Mean scores of depressive symptoms	(1) Receiving no care	11.202	11.088	-0.114	-2.292 **
	(2) Receiving informal care	12.145	11.487	-0.658	-3.953 ***
	Difference (1) – (2)			0.544	3.133 ***
	(3) Not receiving intensive informal care	11.064	11.219	0.155	1.749 **
	(4) Receiving intensive informal care	11.805	11.740	-0.064	-0.336
	Difference (3) – (4)			0.220	1.038

Notes: ADL= activities of daily living. Intensive informal care is defined as more than 20 hours per week (Hu and Li, 2018; Vlachantoni et al., 2013). *** p<0.01, ** p<0.05, * p<0.1.

Table 10 reports the relationship between informal care and health among older people using both FE model and lagged FE models, which highlights the importance of taking reverse causality into consideration. Neglecting to address the reverse causality of health on receiving care would have led us to conclude that those receiving informal care in the previous wave have 1.240 additional increase in ADL limitations over time (β=1.240, ρ<0.01). To minimise the potential impact of reverse causality, lagged informal care receipt variable is included and the findings are opposite, i.e., receiving informal care is associated with a significantly slower progression of functional limitations. All other things being equal, those who receive informal care in the previous wave experience 1.467 additional decrease in number of ADL limitations over time (β=-1.467, ρ<0.01). I then add the interaction between informal care receipt and household per capita income into the lagged FE model to examine the different effects of informal care receipt across older people with different income. The result shows that for those receiving informal care, an additional unit increase in income significantly translates to 0.111 additional decrease in number of ADL limitations between study waves (β=-0.111, ρ<0.05). This means that the protective effects of receiving informal care against the progression of functional limitations are more pronounced among older people with higher income, compared to those with lower income.

In terms of depressive symptoms, without considering potential reverse causal effects, FE model shows that those receiving informal care in the previous wave have more depressive symptoms over time, but this association is not significant (β=0.174, ρ>0.05). After mitigating the reverse causality, I find that those receiving informal care in the previous wave have fewer depressive symptoms between study waves, but this association is not significant, either (β=-0.395, ρ>0.05). I then add the interaction between informal care receipt and household per capita income into the lagged FE model to examine the different effects of informal care receipt on depressive symptoms of older people with different income. The result shows that there is no significant difference in effect of informal care receipt on depressive symptoms between those with lower and higher income (β=0.000, ρ>0.05). In conclusion, I do not find any significant effects of informal care receipt on depressive symptoms.

Table 10. Relationship between receiving informal care and health among older people

	Number of ADL limitations			Depressive symptoms		
Variables	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**
Receiving informal care	1.240 (0.024) ***	-1.467 (0.207) ***	-0.539 (0.387)	0.174 (0.130)	-0.395 (0.253)	-0.397 (1.103)
Receiving informal care* Income (ln)			-0.111 (0.044) **			0.000 (0.128)
Income (ln)	0.001 (0.006)	-0.015 (0.014)	-0.006 (0.014)	-0.019 (0.027)	0.047 (0.041)	0.047 (0.042)
Age						
65-80	Ref	Ref	Ref	Ref	Ref	Ref
80+	-0.015 (0.030)	-0.071 (0.081)	-0.069 (0.081)	0.043 (0.139)	-0.059 (0.242)	-0.059 (0.242)
Gender						
Female	Omitted	Ref	Ref	Omitted	Ref	Ref
Male	Omitted	-0.131 (0.043) ***	-0.132 (0.043) ***	Omitted	-1.155 (0.149) ***	-1.155 (0.149) ***
Education attainment						
No education	Omitted	Ref	Ref	Omitted	Ref	Ref
Elementary school	Omitted	0.012 (0.035)	0.009 (0.035)	Omitted	-0.400 (0.144) ***	-0.400 (0.144) ***
Middle school and above	Omitted	0.171 (0.073) **	0.168 (0.073) **	Omitted	-0.435 (0.306)	-0.435 (0.306)
Marital status						
Others	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	-0.054 (0.057)	-0.105 (0.137)	-0.106 (0.137)	-0.040 (0.267)	-0.167 (0.408)	-0.167 (0.408)
Married	-0.074 (0.057)	-0.030 (0.135)	-0.024 (0.135)	-0.498 (0.264) *	0.112 (0.404)	0.112 (0.404)
Place of residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	-0.047 (0.041)	0.354 (0.093) ***	0.351 (0.093) ***	0.629 (0.189) ***	0.035 (0.273)	0.035 (0.273)

Rural	-0.066 (0.041)	0.391 (0.095) ***	0.389 (0.095) ***	0.702 (0.192) ***	-0.118 (0.279)	-0.118 (0.279)
Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.095 (0.134) ***	0.030 (0.065)	0.029 (0.065)	-0.373 (0.124) ***	0.237 (0.193)	0.238 (0.193)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.069 (0.031) **	0.060 (0.072)	0.064 (0.072)	-0.104 (0.143)	0.361 (0.215) *	0.361 (0.215) *
Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.001 (0.026)	-0.058 (0.059)	-0.060 (0.059)	-0.239 (0.121) **	0.135 (0.176)	0.135 (0.176)
Self-rated health						
Poor	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.115 (0.024) ***	0.051 (0.060)	0.051 (0.060)	-1.374(0.109) ***	0.220 (0.176)	0.221 (0.176)
Good	-0.138 (0.025) ***	0.149 (0.063) **	0.152 (0.063) **	-2.434 (0.113) ***	0.529 (0.186) ***	0.530 (0.186) ***
Number of chronic diseases	0.014 (0.007) **	-0.012 (0.016)	-0.010 (0.016)	0.055 (0.032) *	-0.072 (0.048)	-0.072 (0.048)
Cognitive function scores	-0.029 (0.002) ***	0.002 (0.005)	0.002 (0.005)	-0.055 (0.008) ***	0.025 (0.014) *	0.025 (0.014) *
Number of ADL limitations		0.942 (0.159) ***	0.949 (0.159) ***	0.203 (0.055) ***	-0.125 (0.124)	-0.125 (0.125)
Depressive symptoms	0.009 (0.003) ***	-0.010 (0.006) *	-0.011 (0.006) *		-0.011 (0.027)	-0.011 (0.027)
N			4,396			

Notes: Ref=reference. ADL= activities of daily living. FE= Fixed effects. Cells represents coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

I further focus on informal care recipients, examine the relationship between intensity of informal care and health, as shown in Table 11. In terms of functional limitations, without considering reverse causality, FE model shows that additional increase in hours of informal care received in the previous wave significantly translates to more functional limitations over time (β=0.292, ρ<0.05). The findings are different after mitigating the reverse causality. Lagged FE model shows that those receiving more hours of informal care in the previous wave have fewer ADL limitations over time, but this association is not significant (β=-0.157, ρ>0.05). The interaction between hours of informal care and income is not significant, either (β=-0.111, ρ>0.05), suggesting that the relationship between hours of informal care and functional limitations does not significantly vary by income. Similar trends are observed in the relationship between hours of informal care and depressive symptoms. Specifically, the effect of hours of informal care on depressive symptoms is not significant, and this effect does not significantly vary across income. In conclusion, I find no significant effects of hours of informal care on the health of care recipients.

Robustness check

I perform three sets of robustness check (see Appendix B). The first robustness check includes those using formal home- and community-based care as the primary source of care into the sample. I change the first independent variable, a binary variable, to a categorical variable, comprising three sets of binary variables: no care received, informal care received as primary source, and formal home- and community-based care received as primary source. The results are same as the main results. Specifically, as Appendix B1 shows, compared to those without care, those who receive informal care in the previous wave have less severe functional limitations in the following wave (β=-1.117, ρ<0.01), those who receive formal care in the previous wave also experience a decrease in number of ADL limitations over time (β=-1.244, ρ<0.01). Compared to those with lower income, the protective effects against functional limitations are much greater among those with higher income (β=-0.077, ρ<0.05). With regard to depressive symptoms, compared to those without care, those receiving informal care in the previous wave experience 0.469 additional decrease in depressive symptoms over time, but it is not significant at the significance level of 0.05 (β=-0.469, ρ>0.05), the effects on depressive symptoms does not significantly vary across income groups either.

The second robustness check replaces income, a continuous variable, with a categorical variable, income quintile groups. As Appendix B2 and B3 show, the protective effects of receiving informal care on functional limitations are still more pronounced among older people in higher income quintile groups, compared to those in lowest income quintile groups. The third robustness check replaces hours of informal care, a continuous variable, with a binary variable, ‘whether receiving intensive informal care or not’. I observe similar results for both robustness checks as with the main specification in Appendix B4. that is, there is no significant effect of receiving intensive informal care on health of care recipients, and this effect does not vary significantly by income.

Table 11. Relationship between intensity of informal care and health among informal care recipients

	Number of ADL limitations			Depressive symptoms		
Variables	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**
Hours of informal care (ln)	0.292 (0.054) ***	-0.157 (0.154)	1.985 (2.525)	0.167 (0.127)	-0.318 (0.339)	-2.542 (2.371)
Hours of informal care (ln) * Income (ln)			-0.111 (0.157)			0.243 (0.287)
Income (ln)	-0.077 (0.061)	-0.048 (0.146)	0.642 (0.712)	0.076 (0.138)	-0.625 (0.219) ***	-1.352 (0.918)
Age						
65-80	Ref	Ref	Ref	Ref	Ref	Ref
80+	0.272 (0.383)	-0.626 (1.196)	-0.388 (1.549)	-0.697 (0.864)	3.169 (1.474) **	3.762 (1.867) **
Gender						
Female	Omitted	Ref	Ref	Omitted	Ref	Ref
Male	Omitted	-0.135 (0.424)	0.161 (2.302)	Omitted	-2.601 (1.589)	-2.595 (1.499) *
Education attainment						
No education	Omitted	Ref	Ref	Omitted	Ref	Ref
Elementary school	Omitted	-0.008 (0.658)	-0.590 (1.886)	Omitted	3.340 (1.659) **	3.214 (1.666) *
Middle school and above	Omitted	0.594 (0.846)	0.602 (0.742)	Omitted	2.891 (2.527)	0.704 (2.348)
Marital status						
Others	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	-0.236 (0.701)	3.033 (1.923) *	3.431 (2.072) *	0.795 (1.582)	1.990 (2.583)	0.081 (1.121)
Married	0.002 (0.672)	2.382 (1.345) *	1.85 (2.185)	-0.772 (1.517)	0.661 (1.179)	-1.344 (2.346)
Place of residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	-0.903 (0.390) **	-0.374 (0.728)	-0.939 (1.029)	0.313 (0.889)	2.073 (1.647)	0.965 (0.643)

Rural	-0.922 (0.386) **	-0.372 (0.639)	-0.617 (0.817)	0.395 (0.880)	0.978 (0.647)	-0.042 (0.995)
Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.334 (0.308)	-0.034 (0.807)	-0.299 (0.925)	0.018 (0.697)	2.158 (1.127) *	1.964 (1.209)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.293 (0.375)	-0.253 (1.062)	-0.191 (1.177)	0.532 (0.846)	1.123 (1.816)	-0.661 (1.586)
Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.131 (0.355)	0.330 (0.714)	0.620 (0.838)	-1.226 (0.799)	-0.881 (1.413)	-0.536 (1.491)
Self-rated health						
Poor	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.240 (0.203)	0.157 (0.439)	0.513 （0.664）	-0.584 (0.468)	3.043 (1.124) ***	2.475 (0.902) ***
Good	-0.400 (0.232) *	0.815 (0.460) *	1.219 （0.496） **	-2.366 (0.508) ***	3.282 (1.067) ***	3.326 (1.864) ***
Number of chronic diseases	0.053 (0.057)	-0.174 (0.141)	0.135 (0.708)	0.266 (0.129) **	0.200 (0.241)	0.087 (0.253)
Cognitive function scores	-0.028 (0.013) **	0.020 (0.025)	0.065 (0.138)	-0.043 (0.028)	-0.037 (0.065)	-0.008 (0.065)
Number of ADL limitations		0.436 (0.236) *	0.845 (0.131) ***	0.237 (0.133) *	-0.556 (0.416)	-1.080 (0.513) **
Depressive symptoms	0.047 (0.026) *	0.094 (0.163)	0.119 (0.172)		-0.012 (0.132)	0.079 (0.172)
N			1,687			

Notes: Ref=reference. ADL= activities of daily living. FE= Fixed effects. Cells represents coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

7.4 Discussion

This study investigates the effects of informal care on health trajectories, that is, functional limitations and depressive symptoms, and diverse effects across older people with different income in China. It has several new and compelling findings. Receiving informal care significantly slows down the progression of functional limitations, but does not have significant effect on reducing depressive symptoms. Besides, the protective effect of informal care on slower increase in functional limitations is significantly more pronounced among those with higher income, compared to those with lower income. Focusing on those receiving informal care, there is not any significant relationship between longer care hours and better health outcomes.

The findings are consistent with existing studies in China (Hu and Li, 2018; Yang and Tan, 2019), but different from studies in Western countries (Lin and Wu, 2011). This may be attributed to the fact that people in different social or cultural groups interpret the meaning of informal care receipt and provision differently. For older people in Western countries, performing daily activities with help means reliance on family members, decreasing their sense of control, threatening self-esteem, and eventually brings negative consequences for health (Lin and Wu, 2011). However, influenced by Confucianism, people in China emphasise the importance of family cohesion and filial piety. For Chinese older people, they place more importance on families than on their own sense of control, and they take great pride in their dependence on family members and feel blessed if they have access to family care in later life (Chen and Silverstein, 2000). Therefore, social values in Chinese society might provide buffering effects against negative consequences, and this empirical evidence seems to support this argument.

Focusing on informal care recipients, findings that more hours of informal care do not significantly lead to less functional limitations or depressive symptoms is consistent with some existing studies (Hu and Li, 2018; Silverstein et al., 2006). One possible explanation is that although adult children in China believe that it is their duty to care for older people in the family, the sense of obligation cannot prevent harmful effects of providing round-the-clock care. In particular, an increase in hours of care would lead to less time on work, social activities, and rest. In some cases, routine night-time caregiving is needed, which seriously disrupts adult children's daily routines, such as sleep, leading to greater physical and

psychological pressure, and continuously challenges the boundary of the buffering effects of social values (Hu and Li, 2018). Another possible explanation is that informal carers usually lack professional knowledge and skills. When older people have severe functional limitations, they may require professional care, such as rehabilitation care. Solely relying on adult children may not fully satisfy their need for professional care to maintain health (Yang and Tan, 2019). Therefore, the protective effects of informal care may be weakened or even disappear with the increase in hours of informal care.

Evidence that the effects of informal care are more pronounced among high-income groups support the third hypothesis. It should be noted that such finding is under the assumption that family carers and care recipients share similar levels of socioeconomic status. Socioeconomic status is closely related to key social resources and knowledge. For older people with lower income, their family carers normally have more difficulties in finding a job and making money (Pampel et al., 2011). In this case, crowding out time to provide care increases the probability of being forced to reduce or quit employment, putting themselves at risk of poverty, making them feel overburdened. Such great pressure may result in harmful caregiving behaviours, such as screaming, making the relationship between adult children and older people more strained, reducing the quality of care (Thoits, 2011). Even when they provide care in a proper way, they usually have few learning opportunities and limited health knowledge. For example, they are more likely to engage in health-damaging behaviours, such as drinking, and smoking (Pampel et al., 2011). Influence by carers, low-income older people may adopt unhealthy behaviours, which are harmful to their health (Thoits, 2011). On the contrary, for older people with higher income, their family carers usually have more resources and coping strategies to deal with daily challenges, as well as more knowledge and information on healthy lifestyles. High-income older people are less likely to engage in unhealthy behaviours because they are more likely to receive high-quality care in an appropriate manner.

Findings from this study have important implications for LTC system policies in China. Informal care is often regarded as ‘unpaid care’ in LTC system, but this does not mean that hidden costs of informal care can be ignored. It is crucial for the policymakers to recognise informal cares’ contributions, protect their health and well-being in order to make informal care more sustainable. Flexible work arrangement is one of measures to help informal carers in balancing work and care. In Western countries, such as France, employees can apply

for the carer leave for up to three months with the possibility of renewal. During this time, they could ask their employer to temporarily interrupt their professional activity, while keeping their position and rights in the company. Meanwhile, they can receive benefit from the daily home support allowance paid by social security (United Nations Economic Commission for Europe (UNECE), 2019). Monetary compensations, such as cash benefits, is another measure to compensate the loss of productivity due to caring hours. This approach is implemented in many ageing societies. For example, in Ireland, informal carers receive allowance to provide full-time care. This allowance will be paid for an additional twelve weeks following the death of older people, because when the caring role ends, they require a transition period during which they can adapt to and plan for their life after caring (Rhee et al., 2015). Moreover, provision of respite care is considered as another solution to relieve care burdens for the overstretched family carers. For example, in Finland, there is a centre to provide counselling services, so that carers will not feel isolated or helplessness (UNECE, 2019). The Chinese government should consider similar policies. Taking protective effects of informal care into consideration, they should provide care leave entitlements, direct cash benefits, as well as respite care services to carers, to make informal care more sustainable.

The fact that the protective effects of informal care tend to dissipate with more hours of care received does not mean that informal care is useless, but that primarily relying on informal care is not a sustainable option and more measures should be taken to sustain the protective effects. In many Western countries, older people receive both informal and formal care at home (Van Groenou and Boer, 2016). This not only improves care quality, but also share the responsibilities of caregiving and reduce the workloads of informal carers. For example, in Malta, each older people with severe functional limitations are provided with a qualified formal carer at home, with help in daily activities and rehabilitation services (UNECE, 2019). Providing skills training programme for informal carers is another choice to provide professional care. It should be noted that training will not place heavy burden for family members, but to help them protect themselves from burnout. In Slovenia, the government develops and implements a community-based training programme for informal carers to learn how to provide high-quality care more efficiently and to protect themselves from the negative effects of caring (Spasova et al., 2018). However, these formal home- and community-based care services are largely underdeveloped in China, especially in rural and undeveloped areas. Government should step in to provide more comprehensive home- and community-based care services.

This study finds that receiving care in daily activities does not significantly reduce depressive symptoms among older people. This implies that care in daily activities cannot easily solve mental health problems, attention should be given to other types of social support for older people, such as emotional support. In the UK, enhancing older people's mental health has been included as one of goals in national LTC system. Communities and voluntary sections often organise activities to provide professional guidance to depressed older people, such as regular contact with clinical psychologists and psychiatric nurses, which is effective in promoting social interaction and improving their psychological well-being (Naylor et al., 2016). There seems to be insufficient and inadequate attention paid to this vulnerable population in China. More serious mental health problems could exacerbate the risk of further impairment of daily functioning and cognition. Therefore, it is necessary to provide high-quality and timely psychological services to those in need.

Last but not least, the Chinese government needs to pay more attention to older people with lower income. Compared to those with higher income, those with lower income generally have more functional limitations, resulting in greater need for care (Sun et al., 2020). However, the protective effects are less pronounced among them, which means that they might experience a quicker decline in health trajectory, generating larger inequalities in health between those with lower and higher income. In view of this, there is a pressing need for government to buttress formal care services to support these disadvantaged people. Many European countries have established social welfare system to provide them with affordable access to formal care services. For example, in Germany, eligible low-income older people are given priority access to formal care services, with LTCI benefits and special subsidies from the tax-funded social assistance system provided by local municipalities to cover uncovered costs (Campbell et al., 2010). In 2012, China piloted its first LTCI program in Qingdao, which was later expanded to Nanjing and other cities, to cover professional geriatric services for those with substantial or critical care need (Du, 2015). However, there are still a large number of low-income people who cannot get access to formal care. In some cities, only those who are qualified as 'Three Nos' or 'Five Guarantees' have free-of-charge access to publicly formal care services. This entitlement bias has essentially excluded a large proportion of low-income older adults (Yang et al., 2016). For those who seek private formal care services, although some fees can be covered by LTCI system, co-payments are still too high to afford (Yang et al., 2020). The less pronounced effects of informal care and the lack

of affordability of formal care are associated with a higher risk of being further decline in health. More measures should be taken to provide accessible and affordable formal care to low-income groups in China.

Some limitations of this study should be noted. Among those with informal care receipt as the primary source of care, I cannot differentiate clearly whether the individual relies only on informal care or relies on both informal and formal care as this information is not collected by the survey. Although this may result in the overestimation of the effect of informal care in this study, it should be noted that this may not change the study findings as 95% of Chinese older adults living at home are cared for only by family members (Peng and Wu, 2020). As with other longitudinal studies, CLHLS suffered from attrition resulting from both mortality and nonresponse, which may lead to sample selection bias. This may not raise major concern because earlier studies using this dataset showed that there were no systematic differences in response and attrition rates according to key characteristics (Zeng, 2004). Moreover, intensity of informal care is a comprehensive indicator, which could not be easily measured by hours of informal care. It may also depend on what and how help provided. For example, same hours of help with mobility and bathing may not reflect the same intensity, same hours of help in same tasks with different quality may not reflect the same intensity. Thus, the findings on hours of informal care should be interpreted with caution. Further information on intensity, such as hours of care in specific tasks, is needed. Based on previous studies dealing with reverse causation (Hu and Li, 2018; Lin and Wu, 2011), I use lagged fixed effects model to reduce the impact of health on informal care receipt. However, this analysis could not completely solve the issue of reverse causality. Studies in the future using alternative methods, such as instrumental variable, will be useful to identify the causal mechanisms underlying associations observed.

Chapter 8. Impacts of informal care receipt on health care utilisation of older people

Does informal care reduce health care utilisation in older age? Evidence from Chinese Longitudinal Healthy Longevity Survey[3]

Abstract

Studies in Western countries suggest that receiving informal care from family members may reduce utilisation of health care services. This hypothesis has not been examined in China, where the population is ageing rapidly. We assess the impact of informal care from offspring (children and grandchildren) on health care utilisation and expenditures among older people in China. Data are drawn from the 2011, 2014, and 2018 waves of the Chinese Longitudinal Healthy Longevity Survey. Using lagged model with the instrumental variable approach, we find that the impact of informal care is different by type of health care: More hours of informal care from offspring reduces overall health care utilisation, and in particular, outpatient care utilisation, but it increases inpatient care utilisation and expenditures. Our results suggest that informal care reduces the demand for outpatient care but increases the demand for inpatient care, possible reflecting the fact that the latter involves more advanced procedures for which informal care is not a substitute but a complement. Results highlight the need for incorporating health care impacts in the analysis and evaluation of policies that affect informal care provision.

[3] This chapter is based upon a published co-authored paper (with Dr. Wei Yang and Prof. Mauricio Avendano) in Social Science & Medicine (Wang, Yang, and Avendano, 2022).

8.1 Introduction

As the number of older people living longer in poor health is increasing, demand for older-age care is also rising (WHO, 2015). It is projected that the number of older people with need for care will nearly triple from 101 million in 2010 to 277 million in 2050 (Prince et al., 2013). This suggests that the number of older people who use LTC and health care services is like to increase, significantly contributing to care spending (Suzman and Beard, 2011). Both LTC and health care are provided in order to improve the health status and well-being of care recipients. Existing studies have stressed the interdependences between LTC and health care, with some research suggesting that the availability of informal care reduces utilisation of health care (Van Houtven and Norton, 2004).

Informal care, defined as unpaid care in daily activities provided to older people by a spouse, children, grandchildren, other relatives, neighbours or friends, is the most common form of LTC in most countries (Groenou and Glaser, 2006). Current policy in Western countries favours informal over formal care as the preferred form of LTC provision for two reasons (Yang et al., 2020). On the one hand, older people often feel more comfortable and secure when receiving care from informal carers. Receiving informal care also means more frequent communication and social engagement with family members and friends (Wiles et al., 2012). On the other hand, informal care may also reduce budget expenditures by reducing the demand for health care services (Bremer et al., 2017), and governments around the world have implemented policies to incentivise informal care as a way to reduce health care costs. In California and Missouri, for example, a special tax credit for full-time carers is provided under the argument that supporting informal carers will reduce public expenditures in health care (Van Houtven and Norton, 2004). Yet, existing empirical studies in Western countries do not fully support the hypothesis that informal care provision reduces health care expenditure. Some studies suggest that informal care may reduce adverse health outcomes, reducing length of hospital stay and inpatient expenditures (Van Houtven and Norton, 2008; Weaver and Weaver, 2014). Other studies suggest that informal care significantly increases the use of outpatient surgery and inpatient care costs, as informal carers act as enabling agents of care recipient (Bolin et al., 2008; Torbica et al., 2015; Van Houtven and Norton, 2004).

Addressing this question is particularly important in China. Although the Chinese government has made increased investment in home- and community-based care, these services are either fragmented or non-existent in most parts of the country (Shi and Hu, 2020). As preferences for informal care are unlikely to change drastically in the short-run, informal care will likely continue to be the most important source of LTC in China (Lu et al., 2015). China also offers a unique context given important health reforms over the last decades. In response to rising health demand and higher out-of-pocket (OOP) payments for health care, China has established three main public social health insurance schemes: the UEMI, URMI, and NRCMI. By the end of 2017, 95% of the population was covered by one of these insurance schemes (Du et al., 2017). In order to expand health care coverage and improve social health insurance benefit packages, government health care expenditures have increased rapidly since 2000, exceeding OOP payments in 2015, accounting for more than 65% of total health expenditures (Meng et al., 2019). As Chapter 7 and other existing research suggest (Hu and Li, 2018), older people receiving informal have a slower decline in functional ability and better quality of life. The Chinese government, therefore also encourages informal caregiving in order to reduce health care spending (Lin et al., 2014).

The effectiveness of this policy depends on whether encouraging more informal care leads to cost savings in health care, yet current findings are mixed. Compared with a large number of studies in Western countries, limited studies have investigated this issue in China. Lin et al. (2014) find that informal care significantly reduces the use of outpatient care, but outpatient care expenditures are not investigated in the study. Huang and Fu (2017) find that informal care has no significant impact on the use of health care or health care expenditures. However, this study does not distinguish the effect of informal care on different types of health care, e.g., outpatient care and inpatient care. Chen et al. (2022) find that informal care increases the both of outpatient and inpatient use, but they do not consider reverse causation between informal care and health care (e.g., informal care receipt may influence the use of health care, and vice versa).

Using data from three waves (2011, 2014 and 2018) of the CLHLS, I examine the impact of informal care from children and grandchildren on the health care utilisation and expenditures among older people in China. Given the potential for reverse causation, I use lagged model with the instrumental variable approach that exploits potentially exogenous variation in

informal care receipt to identify its effect on health care utilisation and expenditures. Specifically, I ask the following research questions (RQ):

RQ1: What impact does informal care have on older people's health care utilisation and expenditures?

RQ2: Do these impacts vary by income?

Informal care receipt and health care utilisation

Several studies have examined the relationship between informal care and health care. These studies conceptualise this relationship based on Van Houtven and Norton's (2004) conceptual framework, an extension of the classic Grossman (1972) model of health demand. The classic Grossman model of health demand is to construct a model of the demand for good health. By including informal caregiving into the model, Van Houtven and Norton (2004) propose a family decision-making process where the health status of the older people is modelled as a 'production function' with the amount of care provided by children and use of health care as input factors. In particular, when older people have health problems, the child decides whether to provide informal care, and the parent decides whether to seek health care to maintain health. In this model, the parent chooses how much health care to utilise based on the amount of informal care the child provides.

According to this model, informal care may reduce the demand for health care by preventing or slowing age-related health decline (Van Houtven and Norton, 2004). For example, assistance in bathing and indoor transferring may prevent burns or accidental falls; assistance in feeding or preparing meals may improve diet and nutrition; and regular monitoring in taking medicine may improve the management of chronic disease. Van Houtven and Norton (2004) find that informal care significantly reduces total health care utilisation by reducing the length of hospital stay and Medicare expenditures among single older people in the United States. Based on four waves of the Swiss Household Panel Survey, Weaver and Weaver (2014) focus on the entire older population in Switzerland and report similar findings. Research suggests that more intensive informal care slows the decline in functional ability and improves the recovery process. In addition, an empirical study conducted by Lin et al. (2014) find that longer hours of informal care received is associated with a significant reduction of outpatient care among Chinese older people.

Literature to date has provided mixed results on the relationship between informal care and health care. Some other studies find that informal care increases health care utilisation. Torbica et al. (2015) argue that informal carers play a double role, acting as both providers of care and enabling agents of older people. While informal care in daily activities may improve the health status of older people, it may also increase the probability of identifying significant health problems, help older people to overcome barriers to access, and facilitate the use of health care services. Some empirical studies find support for this hypothesis. Research in the United States find that informal care helps older people with attending outpatient appointments by assisting them on public or private transportation (Van Houtven and Norton, 2004). Research in Sweden suggests that informal carers also look after the older people's medication and can often quickly notify the pharmacy or medical staff if there are problems with the prescription (Condelius et al., 2010). In addition, Bolin et al. (2008) argues that highly professional and highly skilled care cannot be replaced by informal care, and informal carers may encourage and empower older people in using these advanced diagnostic procedures and treatments. They find that informal care increases the probability of using hospital care among single older Europeans.

The empirical evidence in impact of informal care on health care is complex. The inconsistency highlights the complexity of the mechanisms lying behind the relationship between informal care and health care. Several aspects are important to take into account. Studies in Western countries find that the key methodological challenge in identifying the impact of informal care on health care use is endogeneity. Older people probably use informal care and health care simultaneously. Just as informal care may influence health care use, health care use is likely to influence the receipt of informal care. Moreover, unobserved variables that influence both informal care and health care, such as health status, may lead to a spurious positive correlation between informal care and health care. Studies in China have not fully addressed this issue, which may lead to potential bias in estimating the causal effect of informal care on health care.

In addition, the impact of informal care on health care is likely to differ depending on the type of health care (Bolin et al., 2008; Bonsang, 2009). Specifically, informal care is likely to reduce use of health care that requires lower level skills. Since older people could receive low-skilled care from family carers, such as care in daily activities and medication monitoring, their health demands are partly satisfied, resulting in less probability of seeking

some outpatient care services. However, informal care could not reduce the use of some inpatient care that requires higher level skills and more advanced procedures, such as complex surgeries. Because informal carers often lack professional skills, when older people require highly qualified and specialised health care, informal carers are unable to meet their need, and professional care is required in some cases. Therefore, informal care may not reduce the use of inpatient care, which requires more advanced professional skills. This leads to the first hypothesis (H):

> H1: Receiving informal care reduces outpatient care utilisation and expenditures, but not inpatient care utilisation and expenditures.

The impact of informal care and health care may also differ depending on older people's income. As discussed in Chapter 6 and 7, those with higher income receive more amount of informal care, experience slower decline in health trajectory; therefore, they have lower demands for health care, and are less likely to use health care. However, those with lower income receive fewer hours of informal care, experience faster progression of health decline, which may increase the likelihood of using health care. As a result, the second hypothesis is as follows:

> H2: The impact of informal care receipt on health care utilisation differ by income.

8.2 Data and methods

Data and sample

Individual-level data are drawn from the 2011, 2014, and 2018 waves of the CLHLS (Zeng, 2004). The CLHLS started to collect information on expenditures in outpatient and inpatient care separately from 2011. Therefore, this study sample encompasses older people who were interviewed in at least two waves of the 2011, 2014, and 2018 waves. We exclude people living in nursing homes or whose primary source of care was from formal home- and community-based care (60 participants, 1% of the full sample) to reduce potential bias, because the role of informal care cannot be clearly distinguished from the role of formal care. The final sample size comprised 6,348 participants. Table 12 shows the descriptive statistics of the study sample.

Table 12. Descriptive statistics of the sample

Variables	Mean (SD)/Percentages
Dependent variables	
Total health care	
Whether use or not	80.02
Health care expenditures (N=5,080) (RMB)	5932.43 (14584.34)
Outpatient care	
Whether use or not	77.83
Outpatient care expenditures (N=4,940) (RMB)	2507.97 (6863.43)
Inpatient care	
Whether use or not	41.23
Inpatient care expenditures (N=2,617) (RMB)	7160.36 (14821.64)
Independent variable	
Hours of informal care in the last week	24.14 (43.29)
Instrumental variable	
Number of surviving adult daughters	1.72 (1.34)
Control variables	
Age	85.66 (10.89)
Gender	
Female	54.91
Male	45.09
Self-rated health	
Bad	22.03
Fair	36.13
Good	41.84
Number of chronic diseases	1.13 (1.35)
Number of ADL limitations	0.69 (1.54)
Cognitive function	22.49 (9.03)
Smoking	
No	69.53
Yes	19.97
Drinking	
No	74.37
Yes	25.63
Household per capita income last year (RMB)	9990.43 (11663.96)
Education	
None	82.94
Elementary school	14.50
Middle school and above	2.56
Marital status	
Other	2.68
Widowed	59.59

Married	37.74
Living arrangement	
Living alone	18.21
Living with family members	81.79
Money transfers received from daughters and daughters' spouse	2462.55 (4407.37)
Having medical insurance	
No	13.47
Yes	86.53
Residence	
City	15.33
Town	30.02
Rural	54.65
N	6,348

Notes: The unit of this study sample is the individual. These characteristics are the summary statistics across waves. Mean (SD) is presented for continuous variables, and Percentages is presented for categorical variables. ADL= activities of daily living.

Variable specification

Dependent variable: health care utilisation

The outcome of interest is health care utilisation, including utilisation of total health care, outpatient care, and inpatient care. CLHLS collected information on outpatient and inpatient care by asking: 'how much did you spend on outpatient costs before insurance reimbursement last year', and 'how much did you spend on inpatient costs before insurance reimbursement last year'. I aggregate outpatient and inpatient care expenditures to create a new variable, total health care expenditures before insurance reimbursement. For each type of health care, there is a high fraction of observations having no expenditures before insurance reimbursement during the year, so I construct two dependent variables for each type of health care. The first dependent variable is a binary outcome that indicates whether the respondent used health care last year. The second dependent variable is the natural logarithm of the amount of health care expenditures before insurance reimbursement in the last year among those who reported using health care.

Independent variable: informal care

The key independent variable of interest is hours of informal care from children/grandchildren in the last week, a continuous variable constructed based on the question 'How many hours in total did your children, grandchildren and their spouses help you in ADLs last week'.

Covariates

Household per capita income is not treated simply as control variables, but used to find whether the effects of informal care on health care differs according to income. It is introduced in detail in Section 5.3 of Chapter 5. The value of household per capita income in 2011, and 2014 are inflated to 2018 values using Consumer Price Indexes. In all models, I use the logarithmic form of household per capita income to account for non-linearities (Iacobucci et al., 2016; Wooldridge, 2012).

Based on existing studies (Huang and Fu, 2017; Lin et al., 2014), I control for a set of need-related variables and non-need variables. Some covariates are introduced in detail in Section 5.3 of Chapter 5. Since lifestyle may influence the use of health care, I also include smoking and drinking into analysis, based on the questions 'Do you smoke at the present time?' and 'Do you drink alcohol at the present time?'. Smoking and drinking are binary variables with 'no' set as the reference category. Since medical insurance may influence the use of health care, it is included in the analysis. Having medical insurance is a binary variable with 'no' set as the reference category. Money transfers received from daughters and daughters' spouse is included because it may influence their decision to seek health care, which will be discussed further in empirical strategy section. It is a continuous variable measured by the question, 'How much money (including cash and value of materials) did you get last year from your daughters and daughters' spouse'. I logarithmically transformed this variable.

Empirical strategy

To reduce concern of measurement temporality (i.e., the timeframe of independent is last week, while the timeframe of dependent variable is last year), I incorporate a lag to examine the impact of informal care in previous wave on health care use in following wave. In descriptive analyses, I first fit smooth nonparametric LOESS curves point by point through the available data, to explore the relationship between informal care in previous wave and health care utilisation and expenditures in following wave, controlling for age and gender.

Based on the model developed by Van Houtven and Norton (2004), I then model health care utilisation as a function of informal care variables, controlling for other covariates. Because a high fraction of observations has no expenditures before insurance reimbursement for any specific type of care during the year, I use a two-part model (Duan et al., 1984). The first part

is a probit model that predicts the probability of using health care. The second part uses ordinary least squares (OLS) to model the log of health care expenditures, conditional on using health care. I estimate the two-part model separately for total health care, outpatient care, and inpatient care.

As mentioned earlier, informal care is potentially endogenous to health care utilisation. Following earlier studies (Van Houtven and Norton, 2004), I use lagged model with the IV approach to control for unmeasured confounding factors influencing both receiving informal care and using health care. A valid instrument must meet two conditions: First, it must be strongly correlated with the endogenous variable; second, it must be exogenous and have no direct effect on health care expenditures other than through influencing informal care (Wooldridge, 2012). I used an instrument that has been widely used in the literature on informal care: the number of surviving adult daughters (Bonsang, 2009; Huang and Fu, 2017). This instrument is believed to meet these two conditions. In China, rural-to-urban and other job-related migration is more common among adult sons than daughters. This increases adult sons' physical distance and reduces the probability that they provide daily care for parents. As a result, adult daughters more often take the main responsibility of caring for older parents, and providing intensive hours of care (Zeng, 2016).

In principle, the number of adult daughters is exogenous, as parents generally do not have control on the gender of their children. Because the CLHLS is an ongoing nationwide survey collecting extensive data on a much larger population of oldest-old with a comparative sub-sample of younger elders, more than 96% of the study sample is aged 80 and over. Although selective abortion ratios started to rise in the early 1980s due to the one-child policy, this effect is not large enough to influence the gender distribution of adult children in our study sample, as most CLHLS participants had completed their fertility before 1980 (Zeng, 2016). However, a potential concern is that those who are healthy, financially well off and well-educated are more likely to find a partner, and have more resources to create a larger family (McArdle et al., 2006). Therefore, having more surviving adult daughters may indicate better health and socioeconomic status of older people, which may influence health care utilisation. To address this issue, I control for health-related variables and socioeconomic variables in all models, such as self-rated health, income and education. Another potential challenge to our identification strategy is that the number of surviving daughters may influence the amount of monetary transfers older people receive, which may influence their

decision to seek health care. Therefore, I control for monetary transfers received from daughters and their spouse in the models.

Due to the fact that the number of surviving adult daughters does not change across waves for most older people in the sample, variation in the instrument comes primarily from between-individual variations, making it difficult to estimate individual fixed effects models, as the latter only consider changes over time within individuals. Therefore, I use lagged random effects models with IV in a two-part model to exploit both within- and between-individual variation. In the first part, focusing on the whole sample, the general specification for the first stage regression is as follows:

$$IFC_{it-1} = \gamma_0 + \gamma_1\, Adultdaughter_{it-1} + \gamma X_{it-1} + \varepsilon_{it-1} \quad [8.1]$$

where IFC refers to hours of informal care received in the last week, and X refers to control variables including need-related variables, socioeconomic variables, and wave dummy variables.

In the second stage, we regress the probability of using health care on the predicted value of hours of informal care received in the last week from the first stage including all controls:

$$\Pr(Expenditures_{it} > 0) = \alpha_0 + \alpha_1 \widehat{IFC_{it-1}} + \alpha_2 \Pr(Expenditures_{it-1} > 0) + \alpha X_{it-1} + \varepsilon_{it-1} \quad [8.2]$$

where $\Pr(Expenditures_{it} > 0)$ means the probability of using health care, $\widehat{IFC}$ reflects the predicted values of informal care from the first stage, and X includes the same controls as in equation (1). α_1 can be interpreted as the impact of one additional hour of informal care in the previous wave on the probability of using health care in the following wave.

In the second part, I focus on health care users, but use the same specification as in equation (1) and (2) to examine impacts on expenditures, as follows:

First stage equation:

$$IFC_{it-1} = \delta_0 + \delta_1\, Adultdaughter_{it-1} + \delta X_{it-1} + \varepsilon_{it-1} \quad [8.3]$$

Second stage equation:

$$\ln(Expenditures_{it} | Expenditures_{it} > 0) = \beta_0 + \beta_1 \widehat{IFC_{it-1}} + \beta_2 \ln(Expenditures_{it-1} | Expenditures_{it-1} > 0) + \beta X_{it-1} + \varepsilon_{it-1} \quad [8.4]$$

where β_1 captures the impact of one additional hour of informal care in the previous wave on the log of health care expenditures in the following wave among health care users. I present results as marginal effects for each model.

To examine whether household per capita income modifies the impact of receiving informal care on health care utilisation, an interaction between hours of informal care received in the last week and household per capita income is added to the model as following:

First stage equation:

$$IFC_{it-1} = \gamma_0 + \gamma_1\, Adultdaughter_{it-1} + \gamma_2\, Adultdaughter_{it-1} * \ln\left(Income_{i,t-1}\right) + \gamma X_{it-1} + \varepsilon_{it-1} \quad [8.5]$$

Second stage equation:

$$\Pr(Expenditures_{it} > 0) = \alpha_0 + \alpha_1 \widehat{IFC_{it-1}} + \alpha_2 \Pr(Expenditures_{it-1} > 0) + \alpha_3 \widehat{IFC_{it-1}} * \ln\left(Income_{i,t-1}\right) + \alpha X_{it-1} + \varepsilon_{it-1} \quad [8.6]$$

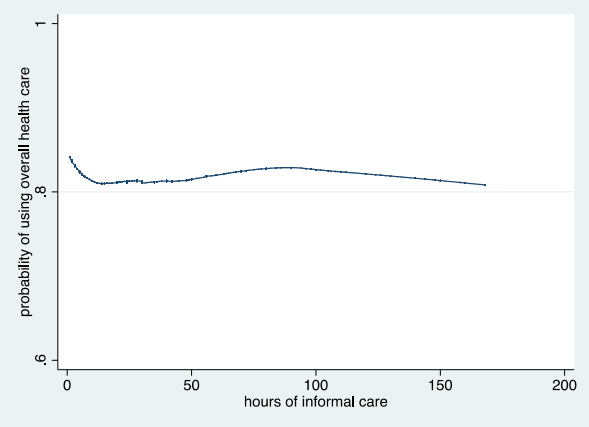
$$\text{Ln}(Expenditures_{it} | Expenditures_{it} > 0) = \beta_0 + \beta_1 \widehat{IFC_{it-1}} + \beta_2 \text{Ln}(Expenditures_{it-1} | Expenditures_{it-1} > 0) + \beta_3 \widehat{IFC_{it-1}} * \ln\left(Income_{i,t-1}\right) + \beta X_{it-1} + \varepsilon_{it-1} \quad [8.7]$$

where the value of α_3 and β_3 denotes the heterogenous effect of informal care in the previous wave on health care in the following wave across different income. A positive value for α_3 and β_3 would imply that the more income the individual has, the greater the effect of informal care receipt on health care is.

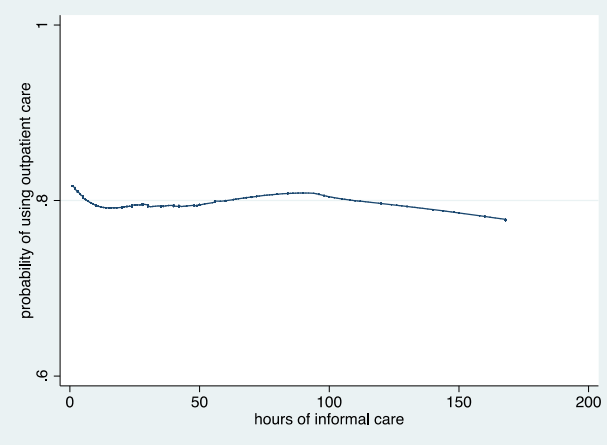
8.3 Results

Figure 8 shows the relationship between informal care in the previous wave and health care utilisation in the following wave. Figure 8-a and 8-b show that there is no clear relationship between informal care in the previous wave and the probability of using overall health care in the following wave, but a positive relationship between informal care and total health care expenditures among health care users. I observe a similar relationship between informal care in the previous wave and outpatient care utilisation in the following wave (Figure 8-c and 8-d). However, Figure 8-e and 8-f suggest that there is a positive relationship between informal care in the previous wave and the probability of using inpatient care in the following wave, while there is not a clear relationship between informal care and inpatient care expenditures.

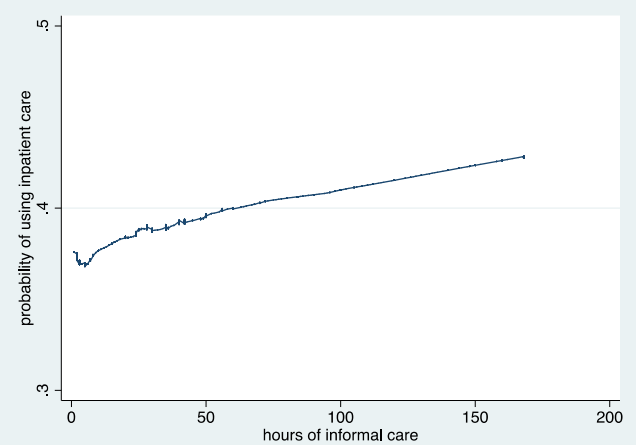
8-a. Probability of using overall health care



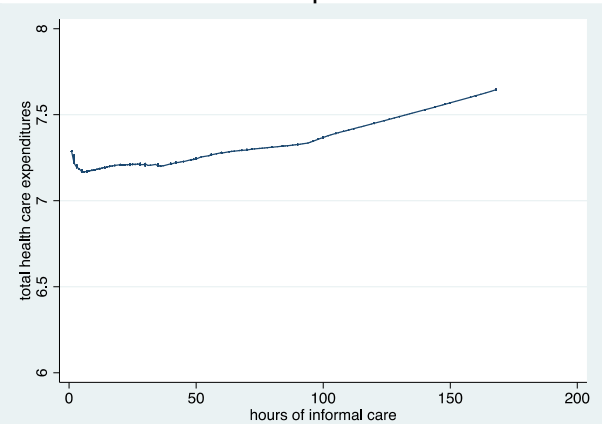
8-c. Probability of using outpatient care



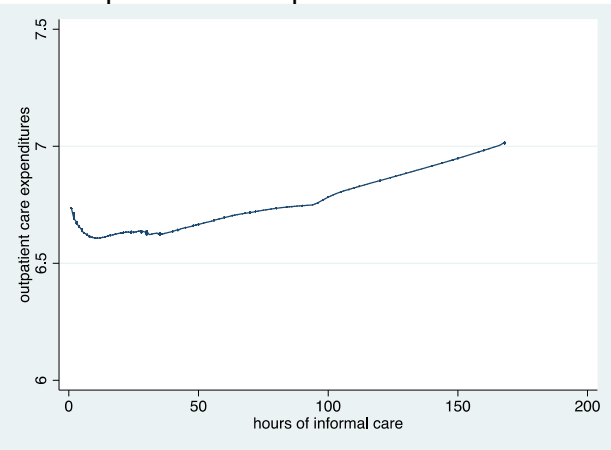
8-e. Probability of using inpatient care



8-b. Total health care expenditures



8-d. Outpatient care expenditures



8-f. Inpatient care expenditures

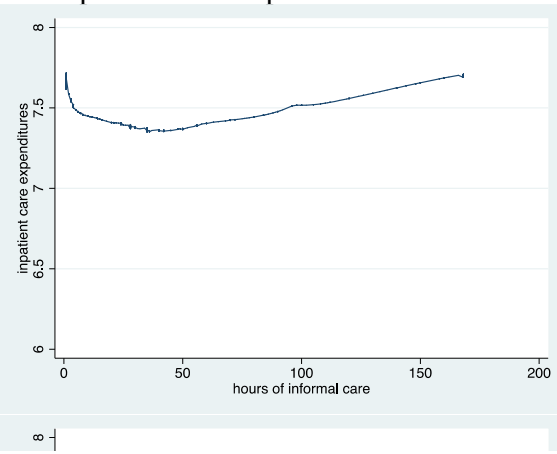


Figure 8. LOESS curve of the relationship between informal care in the previous wave and health care utilisation in the following wave among older people, CLHLS, 2011-2018.

Table 13 reports the results of models to test for the validity of our instrument. Column 2 shows that our instrument has a significant and positive association with hours of informal care received in the first-stage regression. Column 3 indicates that the instrument has a strong predictive power regarding hours of informal care received. Column 4 shows the modified Wu-Hausman test of the exogeneity of informal care for each of the two-part model. In the first-part model, informal care is endogenous to the utilisation of total health care, outpatient care and inpatient care. In the second-part model, informal care is endogenous to the amount of inpatient care expenditures. Based on existing studies, when endogeneity is detected in one but not both parts of a given model, both parts are estimated using instrumental variables (Van Houtven and Norton, 2004, 2008). Thus, we report instrumental variable results for all models, and present the first-stage regression results in Appendix C1-C3.

Table 13. Coefficient and strength of the instrumental variable and exogeneity of informal care

Dependent variable	Coefficient of the instrument	Strength of the instrument	Hausman exogeneity test
Total health care			
Whether use or not	1.307 (0.457) ***	F = 11.16 ***	5.10 **
Expenditures	1.030 (0.362) ***	F = 10.51 ***	2.42
Outpatient care			
Whether use or not	1.258 (0.329) ***	F = 10.07 ***	4.68 **
Expenditures	1.038 (0.372) ***	F = 8.44 ***	1.08
Inpatient care			
Whether use or not	1.060 (0.370) ***	F = 9.37 ***	5.35 **
Expenditures	1.254 (0.572) **	F= 10.54 ***	4.22 **

Notes: The instrument is number of surviving adult daughters. Cells in column 2 represent coefficient (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Table 14 shows estimates of the impact of informal care in the previous wave on total health care utilisation in the following wave using our IV approach. After controlling for the endogeneity of informal care, informal care in the previous wave has a strong negative impact on the probability of using health care in the next wave, but not on health care expenditures among health users. Specifically, a 10-hour increase in informal care in the previous wave reduces the probability of using health care in the next wave by 11 percentage points.

Table 14. Impacts of informal care on total health care utilisation among older people

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.011 (0.002) ***	0.038 (0.086)
Age	0.003 (0.001) ***	-0.014 (0.014)
Gender		
Female	Ref	Ref
Male	-0.014 (0.015)	0.016 (0.091)
Self-rated health		
Bad	Ref	Ref
Fair	0.030 (0.015) *	-0.319 (0.183) *
Good	0.021 (0.025)	-0.470 (0.169) ***
Number of chronic diseases	0.025 (0.011) **	0.222 (0.056) ***
Number of ADL limitations	0.124 (0.020) ***	-0.518 (0.646)
Cognitive function	-0.002 (0.001)	0.024 (0.018)
Smoking		
No	Ref	Ref
Yes	0.008 (0.014)	-0.121 (0.115)
Drinking		
No	Ref	Ref
Yes	-0.004 (0.016)	-0.022 (0.099)
Household per capita income last year (Ln)	0.003 (0.004)	0.065 (0.045)
Education		
Illiteracy	Ref	Ref
Elementary school	-0.011 (0.016)	0.154 (0.097)
Middle school and above	-0.010 (0.034)	-0.172 (0.259)
Marital status		

Other	Ref	Ref
Widowed	-0.000 (0.032)	0.226 (0.202)
Married	-0.057 (0.036)	0.788 (0.386) **
Living with family members		
No	Ref	Ref
Yes	0.055 (0.017) ***	-0.133 (0.267)
Money transfers received from daughters and daughters' spouse	-0.011 (0.006) *	0.017 (0.023)
Having medical insurance		
No	Ref	Ref
Yes	0.009 (0.017)	-.115 (.127)
Residence		
City	Ref	Ref
Town	-.094 (0.031) ***	-0.076 (0.491)
Rural	-.061 (0.019) ***	-0.364 (0.325)
Utilisation/Expenditures in last wave	0.022 (0.035)	0.155 (0.063) **
N	6,348	5,080

Notes: Ref=reference. ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Table 15 shows results on the impact of informal care on outpatient care utilisation. Informal care in the previous wave significantly reduces the probability of outpatient care utilisation in the next wave, but it does not have an impact on outpatient care expenditures among outpatient care users. Specifically, a 10-hour increase in informal care in the previous wave reduces the utilisation of outpatient care by 10 percentage points in the next wave.

Table 16 reports the impact of informal care on inpatient care utilisation. Informal care significantly increases the utilisation of inpatient care, and leads to a significant increase in inpatient health care expenditures among inpatient care users. In particular, a 10-hour increase in informal care in the previous wave increases the utilisation of inpatient care in the next wave by 11 percentage points, while increasing inpatient care expenditures by 26% among inpatient care users. Given that mean inpatient care expenditure is around RMB7,000 (US$1103.80) among users, a 10-hour increase in informal care would lead to around RMB1,820 (=7000×26%) (US$287) increase in inpatient care annual expenditures among users.

Table 17 shows heterogeneous impacts of informal care on health care utilisation among older people with different income. In terms of total health care, the impact of informal care on the probability of using health care does not significantly differ across income; among health care users, the impact of informal care on total health care expenditures does not significantly differ across income, either (ρ>0.1). I find the same results in outpatient care and inpatient care. In conclusion, the impact of informal care receipt on health care utilisation does not vary by income.

Table 15. Impacts of informal care on outpatient care utilisation among older people

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.010 (0.004) **	-0.024 (0.047)
Age	0.002 (0.002)	0.011 (0.022)
Gender		
Female	Ref	Ref
Male	-0.026 (0.016)	0.125 (0.194)
Self-rated health		
Bad	Ref	Ref
Fair	0.021 (0.018)	0.076 (0.197)
Good	-0.001 (0.042)	0.027 (0.227)
Number of chronic diseases	0.028 (0.011) **	0.229 (0.072) ***
Number of ADL limitations	0.111 (0.049) **	0.610 (0.946)
Cognitive function	-0.001 (0.002)	-0.013 (0.020)
Smoking		
No	Ref	Ref
Yes	0.005 (0.014)	-0.189 (0.166)
Drinking		
No	Ref	Ref
Yes	0.007 (0.016)	-0.025 (0.116)
Household per capita income last year (Ln)	0.005 (0.004)	0.098 (0.053) *
Education		
Illiteracy	Ref	Ref
Elementary school	0.001 (0.024)	0.079 (0.164)
Middle school and above	-0.015 (0.038)	-0.005 (0.349)
Marital status		
Other	Ref	Ref

Widowed	0.025 (0.038)	0.064 (0.472)
Married	-0.021 (0.057)	-0.035 (0.921)
Living with family members		
No	Ref	Ref
Yes	0.045 (0.026) *	0.437 (0.478)
Money transfers received from daughters and daughters' spouse	-0.004 (0.002) **	-0.014 (0.027)
Having medical insurance		
No	Ref	Ref
Yes	-0.002 (0.017)	-0.054 (0.144)
Residence		
City	Ref	Ref
Town	-0.071 (0.058)	-0.591 (0.512)
Rural	-0.047 (0.031)	-0.566 (0.296) *
Utilisation/Expenditures in last wave	0.049 (0.057)	0.211 (0.069) ***
N	6,348	4,940

Notes: Ref=reference. ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Table 16. Impacts of informal care on inpatient care utilisation among older people

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	0.011 (0.002) ***	0.026 (0.013) **
Age	-0.002 (0.001) ***	-0.027 (0.007) ***
Gender		
Female	Ref	Ref
Male	0.007 (0.023)	0.135 (0.478)
Self-rated health		
Bad	Ref	Ref
Fair	-0.016 (0.018)	-0.372 (0.611)
Good	-0.044 (0.022) **	-0.267 (0.385)
Number of chronic diseases	-0.007 (0.017)	0.119 (0.165)
Number of ADL limitations	-0.126 (0.025) ***	-0.598 (1.864)
Cognitive function	0.005 (0.002) **	0.001 (0.034)
Smoking		
No	Ref	Ref
Yes	-0.017 (0.015)	-0.066 (0.264)
Drinking		
No	Ref	Ref
Yes	-0.005 (0.015)	0.072 (0.179)
Household per capita income last year (Ln)	0.000 (0.005)	0.014 (0.163)
Education		
Illiteracy	Ref	Ref
Elementary school	-0.006 (0.025)	0.484 (0.158) ***
Middle school and above	-0.012 (0.050)	-0.176 (0.544)
Marital status		
Other	Ref	Ref

Widowed	-0.015 (0.042)	0.676 (0.798)
Married	0.075 (0.037) **	1.005 (1.464)
Living with family members		
No	Ref	Ref
Yes	-0.063 (0.017) ***	-0.156 (0.772)
Money transfers received from daughters and daughters' spouse	0.003 (0.002)	0.010 (0.044)
Having medical insurance		
No	Ref	Ref
Yes	-0.028 (0.020)	-0.153 (0.306)
Residence		
City	Ref	Ref
Town	0.108 (0.036) ***	0.110 (1.348)
Rural	0.065 (0.034) *	-0.261 (0.662)
Utilisation/Expenditures in last wave	0.060 (0.074)	0.276 (0.130) **
N	6,348	2,617

Notes: Ref=reference. ADL= activities of daily living. Cells represent marginal effects (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Table 17. Heterogeneous impacts of informal care on health care utilisation among older people with different income

Variables	Total health care		Outpatient health care		Inpatient health care	
	Utilisation	**Expenditures**	**Utilisation**	**Expenditures**	**Utilisation**	**Expenditures**
Hours of informal care	-0.021 (0.032)	0.030 (0.392)	-0.021 (0.036)	-0.197 (0.603)	0.003 (0.041)	-0.355 (0.856)
Hours of informal care (Ln) * Income (Ln)	0.001 (0.004)	0.001 (0.033)	0.001 (0.004)	0.011 (0.058)	0.002 (0.004)	0.035 (0.085)
Household per capita income last year (Ln)	-0.011 (0.050)	0.045 (0.315)	-0.011 (0.056)	-0.036 (0.204)	-0.014 (0.056)	-0.084 (0.246)
Age	0.002 (0.002)	-0.009 (0.032)	0.002 (0.001)	0.022 (0.038)	-0.002 (0.002)	-0.462 (1.223)
Gender						
Female	Ref	Ref	Ref	Ref	Ref	Ref
Male	-0.020 (0.015)	-0.040 (0.214)	-0.025 (0.018)	0.173 (0.317)	-0.001 (0.038)	0.205 (0.490)
Self-rated health						
Poor	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.015 (0.018)	-0.124 (0.094)	-0.019 (0.018)	-0.071 (0.079)	0.020 (0.021)	-0.254 (0.156)
Good	-0.051 (0.016) ***	-0.293 (0.090) ***	-0.055 (0.018) ***	-0.238 (0.076) ***	-0.049 (0.021) **	-0.126 (0.177)
Number of chronic diseases	0.050 (0.005) ***	0.231 (0.029) ***	0.045 (0.006) ***	0.189 (0.029) ***	0.044 (0.009) ***	0.165 (0.044) ***
Number of ADL limitations	0.012 (0.016)	-0.067 (0.115)	0.013 (0.015)	-0.057 (0.113)	0.020 (0.028)	0.270 (1.081)
Cognitive function	0.005 (0.001) ***	0.018 (0.006) ***	0.006 (0.001) ***	0.013 (0.005) ***	0.004 (0.001) ***	0.012 (0.010)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.013 (0.017)	0.153 (0.089) *	0.009 (0.015）	0.176 (0.078) **	-0.010 (0.021)	0.219 (0.169)
Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.008 (0.018)	0.006 (0.094)	0.015 (0.018)	-0.040 (0.083)	0.006 (0.022)	0.209 (0.174)

Education						
None	Ref	Ref	Ref	Ref	Ref	Ref
Elementary school	0.047 (0.030)	0.141 (0.148)	0.047 (0.031)	0.128 (0.136)	-0.010 (0.035)	0.346 (0.210)
Middle school and above	-0.007 (0.048)	0.061 (0.249)	-0.021 (0.047)	0.136 (0.255)	-0.010 (0.060)	0.117 (0.418)
Marital status						
Other	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	0.025 (0.104)	0.504 (0.549)	0.028 (0.043)	-0.167 (0.832)	-0.014 (0.040)	-0.737 (2.787)
Married	-0.017 (0.101)	1.057 (1.342)	-0.026 (0.061)	-0.560 (1.705)	0.069 (0.039) *	-1.358 (3.876)
Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.012 (0.027)	-0.247 (0.185)	0.028 (0.027)	-0.102 (0.159)	-0.046 (0.040)	-0.434 (0.287)
Money transfers received from daughters and daughters' spouse	-0.003 (0.002)	0.013 (0.020)	-0.003 (0.003)	-0.007 (0.031)	0.004 (0.003)	-0.005 (0.084)
Having medical insurance						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.018 (0.018)	0.033 (0.115)	0.012 (0.019)	-0.042 (0.108)	-0.015 (0.023)	0.373 (0.204) *
Residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	0.053 (0.047)	-0.213 (0.252)	0.077 (0.050)	-0.239 (0.238)	-0.017 (0.064)	0.034 (0.232)
Rural	0.041 (0.046)	-0.224 (0.258)	0.062 (0.048)	-0.280 (0.241)	-0.023 (0.065)	0.087 (0.258)
Utilisation/Expenditures in last wave	0.047 (0.063)	0.212 (0.085) **	0.042 (0.061)	0.232 (0.099) **	0.082 (0.100)	0.200 (0.193)
N	6,348	5,080	6,348	4,940	6,348	2,617

Notes: Ref=reference. ADL= activities of daily living. Cells represent marginal effects (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Robustness check

I perform three sets of supplementary analysis to examine the robustness of our results (See Appendix C). I re-incorporate older people who use formal home- and community-based care in the sample. Appendix C4-C6 show the full results, which show that the results are insensitive to including these participants. I replace overall health care expenditures (i.e., health care expenditures regardless of insurance reimbursement) with OOP payments in health care (i.e., health care expenditures after insurance reimbursement, thus paid by respondents themselves). Results, summarised in Appendix C7-C9, are in line with the main models: a unit increase of informal care reduces utilisation of overall and outpatient health care, but increases the utilisation of inpatient care and inpatient care expenditures among inpatient care users. Finally, I replace the two-part model with a Heckman Selection Model (HSM). I do this because the two-part model assumes that the decision to seek health care and the choice of how much to spend are two independent decisions, yet these two decisions may be influenced by both observable and unobservable factors (O'Donnell et al, 2007). HSM considers the correlation between the two errors in the decision to seek health care and the choice of how much to spend (see Appendix C10 for more details). Appendix C11-C13 show the full results, which are in line with the main findings: a 10-hour increase in informal care reduces the utilisation of outpatient care by 10 percentage points, but increases the utilisation of outpatient care by 8 percentage points, increases the inpatient care expenditures by 24% among inpatient care users.

8.4 Discussion

This study examines the impact of informal care from adult offspring on health care utilisation among older people in China. After controlling for endogeneity of informal care, I find that the impact of informal care is different by types of health care. More hours of informal care reduce the utilisation of overall and outpatient health care, whereas more hours of informal care increase the utilisation of inpatient care and amount of inpatient care expenditures among inpatient care users. I do not observe heterogeneous impact of informal care receipt on health care utilisation and costs among older people with different income.

This study suggests that the impact of informal care on outpatient care differs from that on inpatient care, a finding that is in line with some studies (Friedman et al., 2019; Van Houtven and Norton, 2004). Informal care may be a substitute for outpatient care because it reduces

the probability of health problems, for example, informal carers support older people in managing their health conditions. In support of this view, studies show that informal carers often help with practical daily care tasks, such as eating and monitor medications, provide company, and 'keep an eye' on older people, leading to better health outcomes for older people (Beesley, 2006). By addressing potential endogeneity using IV approach, this study demonstrates significant impact of informal care on outpatient care, and these results are consistent with previous studies, showing that informal care leads to less frequent use of outpatient care (Lin et al., 2014).

On the other hand, this study shows that informal care increases inpatient care, a finding reported in previous studies (Bolin et al., 2008). This suggests that informal care may be complementary –rather than a substitute- for inpatient care. Studies find that adult children may act as enabling agents and assist older people in receiving more advanced care treatments (Chen et al., 2022). For example, they may quickly notice parents' need, notify doctors, and ensure their older parents receive the treatment they need in the hospital. A study in China find that older people with family carers tend to have longer hospital stays, compared with those who do not have family carers (Yu and Jin, 2018). For those with severe functional or cognitive impairment, children play an important role in making medical decisions, and they help parents to access professional health care for longer period of time or until recovery (Qian, 2017; Van Houtven and Norton, 2004).

This study is the among the first to examine heterogeneous impacts of informal care on health care utilisation across different income groups. Despite the fact that those with lower income receive less amount of informal care, experience quicker decline in functional ability and have stronger health demands, it is found that they do not have higher likelihood of using health care, compared to those with higher income. This might be due to the lack of health care affordability. As discussed in Chapter 2, health care insurance system in China is fragmented, with many issues regarding equity in access to health care services (Yang and Wu, 2015; Zhang et al., 2015). In particular, the benefit packages in different health insurance schemes are significantly different, even among those with equal health need. The reimbursement rate for urban employees is higher, and the types of covered services are more diverse. In contrast, those without formal employment or living in rural areas have lower reimbursement rates, and the covered services are limited. As a result, those with formal employment in urban areas are more likely to use hospital services, while those without

formal employment or living in rural areas, who are comparatively poorer, will not go to hospital, even they have strong demands for medical treatment, potentially worsening health inequalities (Du et al., 2017).

Findings from this study have important policy implications for current LTC system in China, where informal care plays a larger role in LTC, and public spending on health care is growing substantially. Research finds that the average number of weekly hours of informal care received rose by 11 hours from 2005 to 2014 among the Chinese oldest-old, and nearly 15% of them reported a 70-hour increase in care from children/grandchildren during that period (Hu, 2020). This study suggests that policies that incentivise informal care may contribute to reduce outpatient health care utilisation. Although informal care is often regarded as unpaid care, these benefits and the opportunity costs for informal carers should not be ignored in the analysis. An example of a policy that encourages informal care is direct cash payments to informal carers, which have a high take-up in some European countries (Zigante, 2018). This study suggests that cash-for-care payments may not only compensate for the loss of labour income associated with caregiving, but also result in lower rates of utilisation of health care, which lead to a reduction of public spending on health care. However, it is worth noting that although informal caregiving provides economic benefits to individuals and governments, over-reliance on informal caregiving may have negative consequences for both individuals and governments. Research suggests that providing highly intensive care reduces carers' wages and harms their employment prospects, leading to negative consequences on carers' well-being and a significant net cost to government revenues (Jacobs et al., 2013; Skira, 2015). As a result, governments need to strike a balance between encouraging informal care and increasing the supply of publicly funded formal home- and community-based care.

The finding that informal care increases inpatient care utilisation and costs, which again reinforces the importance of informal care from the perspective of preventing older people from forgoing necessary health care. Support from children/grandchildren may help older people to overcome barriers and improve access to necessary hospital care, for example, by encouraging them to attend hospitals appointments, informing doctors about their need, taking necessary screening tests, and receiving essential professional care. In addition to incentivising informal caregiving, I emphasise the importance of government policies that support informal carers when the care burden becomes heavy and older people require more skilled assistance. There is a pressing need for the policymakers to consider the burden of

informal care on family members, and to balance further reliance on informal care with appropriate supply of formal LTC services, such as day care, respite care, community care and counselling (Robards et al., 2015). In European countries, the governments are rapidly adopting a hybrid model of formal and informal care provision, in which professional health actors and informal carers collaborate to complement one another in order to strengthen the entire LTC delivery systems for older people (Van Eenoo et al., 2016). Similar measures should be adopted by the Chinese government so that the burden of care will not be predominantly shouldered by informal carers and informal care becomes more sustainable.

Furthermore, more measures should be taken to support older people with lower income. Compared to those with higher income, those with lower income generally have more functional limitations, leading to stronger health demands (Sun et al., 2020). As discussed in Chapter 7, the effects of informal care among low-income groups are less pronounced, they will experience a faster decline in health trajectory and may seek medical care more frequently to meet their health demands. However, there is no evidence to support this hypothesis in this study. One possible explanation is that low-income people are more likely to face access barriers or pay higher co-payments due to their low reimbursement rate and limited services covered by health insurance. As a result, the goal of health care insurance system should be not only universal coverage for all people, but also universal health care insurance with equitable benefits for socioeconomic disadvantaged groups. When compared to their advantaged counterparts with similar health need, disadvantaged groups have the right to achieve an equitable health outcome after receiving fair treatment from health care services. To meet their need, the government can improve their benefit packages, such as financial benefits or more covered services (Liu and Wong, 2016).

This study has several strengths, but some important limitations should be noted. First, I did not have data on insurance claims, and all information on health care expenditures came from survey self-reports. Inaccurate recall and misreporting may have led to reporting bias. Second, unlike many international datasets, the CLHLS does not provide longitudinal weights. However, as suggested by the CLHLS research team, weights may not be required when performing regression analysis as long as age, gender, and urban/rural residence are controlled for. Third, CLHLS only collects information on care provided by children or grandchildren; it does not collect information on hours of care provided by other sources of care, such as a spouse, sibling or other family members. Future studies should examine how

care received from a spouse or family members other than offspring affect utilisation of healthcare. Fourth, the data does not enable a clear distinction between help received inside and outside the household. It is difficult to measure care received inside the household, as individual who co-reside with adult children may not consider help from co-residing children as a source of support. Lastly, the data does not contain information on preventive health care, such as regular physical check-ups and dental care. Future studies should investigate how receiving informal care influence the use of preventive health care. Despite these limitations, this study produces new and compelling results regarding the impact of informal care on health care utilisation among older people in China.

Chapter 9. Discussion and conclusion

9.1 Introduction

The overarching aim of this thesis is to investigate the impact of income-related inequalities in informal care receipt on health among older people using the case study of China. The research questions that this thesis addresses are: Is there horizontal inequity in the receipt of informal care according to income? What effect does informal care have on older people's health trajectories over time? What impact does informal care have on older people's health care utilisation and expenditure? Do these effects vary across different income groups? Chapter 6 examines income-related inequalities in informal care receipt among older people in China. Chapters 7 and 8 integrate the exploratory information presented in Chapter 6 by examining the heterogeneous effects of informal care receipt on health and health care utilisation among older people, closely observing low-income groups to understand whether this socioeconomically disadvantaged group will be further disadvantaged in health.

In this chapter, section 9.2 summarises the results of the empirical chapters and outlines their contributions. Section 9.3 discusses policy implications to address issues of income-related inequalities in informal care receipt in China, to help the government establish a comprehensive LTC system. Sections 9.4 discusses the limitations of the research presented in this thesis. Sections 9.5 serves as a point of departure to outline possible avenues for future research to further extend the understanding of LTC and health.

9.2 Discussion of main findings

This thesis's main research question is whether income-related inequalities exist in the receipt of informal care and how this issue relates to health and health care use among older people in China. I begin the empirical analysis by investigating income-related inequalities in informal care receipt in Chapter 6. I find that there are no significant inequalities in the probability of receiving informal care; however, among those receiving informal care, higher income is significantly associated with more hours of informal care, even after controlling for care need. The pro-rich inequality in hours of informal care significantly increases as the number of ADL limitations increases. This raises concerns about low-income older people, especially those with more ADL limitations because they are less likely to receive informal care than those with higher income, resulting in greater health demand and unmet care need.

Using lagged FE models, Chapter 7 provides evidence on the effects of receiving informal care on functional limitations and depressive symptoms of older people over time. Receiving informal care significantly slows down the progression of functional limitations but does not have a significant effect on reducing depressive symptoms. Furthermore, the protective effect of informal care on the slower increase in functional limitations is significantly more pronounced among those with higher income, compared to those with lower income. Focusing on those receiving informal care, no significant relationship exists between longer care hours and improved health outcomes. These findings suggest that informal care has protective effects against functional ability decline and that these contributions differ by older people's socioeconomic status. Compared to older people with higher income, those with lower income receive less informal care and experience a quicker decline in functional ability; therefore, they may exhibit worse health outcomes, thus widening the gap in health between those with lower and higher income.

Using the IV approach, Chapter 8 investigates the impact of receiving informal care on health care utilisation of older people. This study demonstrates that the impact of informal care is different by type of health care: more hours of informal care from offspring reduces overall health care utilisation, and in particular, outpatient care utilisation, but it increases inpatient care utilisation and expenditures. There is no heterogeneous impact of informal care receipt on health care utilisation among older people with different income. These findings indicate that informal carers play a dual role when providing care: on the one hand, they provide support with daily activities and thus satisfy health demands, reducing the demand for outpatient care. On the other hand, carers may also facilitate access to inpatient care by providing advice, motivation, and support to overcome barriers. In other words, informal carers act as both providers of care and better-informed agents to support older people in receiving necessary care. I find no significant difference in the impact of informal care on health care according to income.

In Chapter 6, the evidence that there is a pro-rich inequality in hours of informal care received supports the exchange motivation in intergenerational support proposed by Cox and Jakubson (1995). Due to demographic changes, industrialisation, economic growth, and exposure to Western culture, low-income older people face many barriers in receiving care from family members, especially from adult children. Specifically, rural-to-urban migration

and female labour participation increased migration of adult children to urban areas, leaving older parents behind. The long time and space separation between the adult children and their parents prevent low-income older parents, who are more likely to live in poor areas, from receiving informal care from adult children. Meanwhile, people's attitudes towards family obligations are also changing rapidly. A rise in individualistic values among older people and a decline in filial piety have been observed (An, 2019; Liu, 2015). Cong and Silverstein (2012) argue that intergenerational support is increasing more likely to rely on reciprocity rather than the unconditional willingness of adult children to provide care during modernisation. This perspective poses that adult children are less willing to care for low-income older people because they are less likely to receive gifts or money in exchange. By contrast, adult children are more willing to care for high-income older parents in anticipation of future transfers, such as bequests. The findings provide evidence to support the disproportionate concentration of informal care among high-income groups. In short, low-income older people—those with stronger care needs—receive less informal care.

Chapter 7 makes a significant empirical contribution to test key theoretical models often used to understand the role of LTC on health. One such models is the disablement process proposed by Verbrugge and Jette (1994), indicating that LTC, as a type of extra-individual factors, can help to reduce the negative impacts of functional limitations and slow down the process of disablement. The evidence that receiving informal care significantly protect against the progression of functional limitations supports such theory. Another model for understanding the role of LTC is the stress-buffering model, which indicates that LTC, as a type of social support, redefines the potential stress posed by health decline and prevents psychological distress and depression (Cohen and Pressman, 2004). However, this thesis does not find the protective effect of informal care against depressive symptoms among older people, and thus does not validate this theory. This might be attributed to several reasons. First, this thesis only focuses on support in activities of daily living, rather than frequent communication or other types of emotional support. In other words, the finding only implies that informal support in activities of daily living does not reduce older people's depressive symptoms; future research into the effect of emotional support on depressive symptoms among older people is required. Second, the thesis does not take gender of informal carers into further analysis. Some studies find that depressive symptoms are reduced by assistance from daughters-in-law, but increased when support is from sons (Cong and Silverstein, 2008a). It would be important to investigate gender difference in effect of informal care on

depressive symptoms. Third, the effect of informal care on depressive symptoms may differ by place of residence. There are gaps in social and economic development between urban and rural regions in China, which may lead to a different prevalence of depression and differences in the receipt of informal care among older people living in urban and rural regions. Studies show that older people in rural regions have higher levels of depressive symptoms than those in urban regions in China (Wang et al., 2021). Hu and Ma (2018) report that older people in rural regions are more likely to use informal care, compared to those in urban regions. Therefore, the differences between urban and rural regions should be considered when exploring the effect of informal care on depressive symptoms among older people in China.

Furthermore, neither of these models explicitly mentions socioeconomic inequalities in the effect of LTC on health. Under the assumption that family carers and care recipients share similar levels of socioeconomic status, these models are extended by the finding that the protective effect of informal care on functional ability is significantly more pronounced among those with higher income, compared to those with lower income. According to the diverse pathways between social support and health, it might be because that high-income groups receive a higher quality of care in a more appropriate way than those from low-income groups. An (2019) and Ji (2018) provide evidence that carers from high-income families have more healthy behaviours and lifestyles, possess more resources and coping strategies, and thus are more likely to scientifically remind older people to adopt healthy behaviours, thus enhancing the quality of informal care. It should be noted that those mechanisms underlying these conclusions requires further empirical investigation.

In Chapter 8, the evidence that the impact of informal care on outpatient care differs from that on inpatient care extends the classic Grossman model of health demand (Van Houtven and Norton, 2004), by showing that the impact of informal care on health care varies according to health care skills and procedures. Consistent with some studies (Friedman et al., 2019; Van Houtven and Norton, 2004), informal care may be a substitute for some outpatient care services, which require lower level skills and procedures. More care in daily activities from family members lowers the probability of health problems, helps older people maintain their health against faster decline, resulting in less frequent use of health consultation or monitoring. However, informal care may be complementary for some inpatient care services, which require higher level skills and procedures. Because informal carers lack professional skills, they are unable to fully meet the needs of older people who require specialised health

care, and inpatient care, such as complex surgery, is required in some cases. Furthermore, I extend the classic Grossman model of health demand, by showing the heterogeneous impact across income groups. There is no evidence that low-income groups, who received less informal care and experienced less pronounced effects, have a higher likelihood of using health care. This might be because they face difficulties in meeting care costs. They are more likely to encounter access barriers or incur higher co-payments due to the limited benefit packages and covered services in health insurance schemes. In such circumstances, they would not visit the hospital, and consequently, their health demands would not be met. Disadvantages in informal care and health care may place them at an even greater disadvantage in health.

This thesis makes a methodological contribution to the literature by using econometric approaches with longitudinal data to analyse how income-related inequalities in informal care receipt relates to older people's health outcomes and health care utilisation. A major advantage of longitudinal data is increased precision in estimation. I use CI and random effects models to quantify the direction and magnitude of income-related inequalities in the probability of receiving informal care and the hours of informal care received. I further use advanced quantitative methods to address endogeneity issues. I use lagged FE models to focus on within-individual variation, to examine whether within-individual changes in informal care receipt between waves 1 and 2 are associated with within-individual changes in health outcomes between waves 2 and 3, to minimise the potential impact of the reverse causality of health on receiving informal care, and to investigate the heterogeneous effects by income. Furthermore, I use the IV approach to examine the causal effects of informal care on different types of health care to control for the endogeneity of informal care, and to investigate the heterogeneous effects of informal care on health care by income. This causal approach has the advantage of addressing the endogeneity of informal care caused by reverse causality and omitted variable bias.

9.3 Policy implications

In this section, I will describe in detail this thesis's policy implications. This thesis raises concerns about the need for policies that target low-income groups experiencing

disadvantages in informal care receipt and health, through a variety of policies relating to formal home- and community-based care, informal care, and health care.

9.3.1 Policy recommendations for formal home- and community-based care

This thesis demonstrates that older people with lower income are less likely to receive informal care, and receive less intensive care than their higher-income counterparts. I also show that the effect of informal care on health is weaker for lower-income groups. One option for policymakers to compensate the vulnerable group is to provide formal home- and community-based care services.

Current formal care services cannot respond well to satisfy the needs of low-income groups because these services are not distributed according to population care needs and are not available in less developed areas with a high concentration of low-income groups (Chang et al., 2020). The development of formal care services is particularly affected by policy implementation, economic development levels, geographic restrictions, and traditional ideas. In more developed cities, the governments have greater financial resources to reinforce the implementation of day care centres, door-to-door nursing, and other professional services; however, in less developed cities or rural areas, day care centres and door-to-door nursing are still under discussion and have not been implemented yet (Hu et al., 2018). Besides, along with the rapid development of China's market economy, the market plays an increasingly prominent role in developing formal care. Households in more developed cities tend to exhibit higher income and living standards, thus creating a sizable market to encourage the development of formal care, while households in less developed cities or rural areas are more likely to face financial difficulties, resulting in low levels of consumption on formal care (Wang and Qi, 2021). In addition, less developed areas are usually situated in remote areas with poor transportation links and infrastructure, resulting in higher costs in providing formal care services than in urban areas. This does not conform to the low-cost principles of the market, making it difficult to encourage formal carers to work in remote areas (Chu et al., 2013). Furthermore, the traditional idea of 'raising children for support during old age' still exists with the belief that the responsibility of caring for older parents should be shouldered by their children; paying for formal care is still stigmatised by Chinese rural society to some extent. In contrast, with rapid economic development in larger cities, modernisation widely permeates these cities, traditional values have gone through changes, and older people have

begun to accept formal care from professional carers (Shi and Hu, 2020). Communities in larger cities act as platforms to integrate varied resources to provide formal care services, such as assistance with cleaning and medical treatment. Consequently, high-income groups, who are more concentrated in developed areas, are more likely to have access to formal care, whereas low-income groups, who are more concentrated in less-developed areas, are faced with multi-dimensional access barriers.

Even in areas where formal care services are available, low-income groups still cannot access these services. Although LTCI system China aims to achieve equity in providing formal care services, studies have demonstrated that the impacts of the LTCI system on protecting low-income groups are rather limited; this is mainly because of the target population, benefit packages, and risk selection. Low-income groups are mainly rural residents or urban residents without formal employment, but they are excluded from this system in several pilot cities. The eligibility rules of LTCI are closely related to the status of individual's social health insurance, but studies indicate that approximately 21% of older people with functional limitations in China do not have any health insurance, but they are the most disadvantaged groups with lower income and poorer health statuses (Zhu and Österle, 2019). For those enrolled in health insurance schemes, covered services and benefit packages greatly differ from scheme to scheme. Compared to those enrolled in UEMI scheme, those enrolled in the URMI scheme, who are comparatively poorer, are more likely to incur higher co-payments because of their low reimbursement rate and limited covered services (Yang et al., 2020). Thus, they would not seek formal care despite the urgency. Furthermore, some formal care providers have incentives for risk selection, i.e., assessing if their estimated care expenses will exceed the fixed cost and then rejecting applications from eligible older individuals if this is the case (Yang et al., 2020). In this case, some older people who satisfy all the eligibility rules for receiving funded services are rejected by care providers because they have severe functional limitations, and their care costs are prohibitive. The disadvantages in both informal and formal care will further disadvantage low-income groups, especially those with severe functional limitations, to an even more disadvantaged position.

To reduce access barriers and improve the affordability of formal home- and community-based care, the government should strengthen administrative and fiscal capacity, expand the consumer market, and provide a safety net for those who cannot afford care. The development of formal care services and design of related insurance systems require strong

administrative and financial capacity. The central government should pay attention to poor regions to provide extra public funding for formal care provisions. Encouraging private and non-governmental organisations is also necessary to provide formal care due to the limited funding base and growing older population (Wang and Qi, 2021). In Western countries, the provision of LTC services has traditionally been a cooperation between profit-making and non-profit sectors. For instance, in England, non-profit and private for-profit institutions have cooperated in the LTC provision for years, with 89% of care at home being provided by private sectors (Spasova et al., 2018). Similarly, in Ireland, the severe shortage of public resources brought about the marketisation and privatisation of LTC services, with around 75% of LTC services contributed by private commercial providers (European Commission, 2019). Insights drawn from these countries suggest that the private commercial providers of LTC, non-governmental organisations, and volunteers should also be involved in the formal care system in rural areas.

To expand the consumer market, encouraging older people in less developed areas to use formal care services might be helpful. One possible solution is to change their negative attitude towards formal care. According to studies, with the professional assistance in medication adherence or regular health monitoring, small health concerns can be discovered and treated in time to prevent serious illness and the protective effects of informal care might be sustained (Saloniki and Nizalova, 2019). With suggestions from clinical psychologists and psychiatric nurses in community centres, their depressive symptoms might be alleviated (Barnay and Juin, 2016).

Another way to address inequities is to improve the financial capacity of older people, especially those in low-income groups. The LTCI system should cover both urban and rural residents, with a focus on the lower socioeconomic groups who are at risk of incurring higher-than-expected costs. Some developed countries provide relevant example in this regard. For instance, the U.S. requires mandatory eligibility groups, such as low-income families and individuals receiving supplementary security income; the UK conducts an assessment of eligibility and financial assistance based on the individual's capital and provides a safety net to those with the lowest means (OECD, 2020). The Nanjing government has made the first step to combine both needs and financial assessments in the definition of eligibility to receive subsidised care (Yang et al., 2016). The government provides care vouchers, assistive device subsidies, and other types of subsidies to those falling below the

poverty line or with substantial care needs, and to those aged 70 and above without children. However, the values of these subsidies are far below the average costs. Greater benefits are required to serve as a reliable safety net for those with severe needs who are unable to meet the care costs. This should also be accompanied by a formalised system to facilitate quality monitoring and regulatory oversight to prevent care providers from deterring those in need (Wang and Qi, 2021).

9.3.2 Policy recommendations for informal care

This thesis finds that the protective effects of informal care tend to dissipate with an increase in the hours of care received. This could be attributed to several reasons. First, informal carers may face negative impacts on their life, health, and well-being when providing intensive care. These unfavourable consequences might overwhelm the protective effects of informal care. Second, informal carers usually lack professional knowledge and skills when compared to formal carers. Therefore, policymakers should identify the key challenges faced by informal carers in both low-income and high-income families and provide them with adequate social protection.

The role of becoming an informal carer is challenging. The recognition of informal carers' work is low in society and families. Informal care is often regarded as 'unpaid care' by society, and receiving care from family members during old age is taken for granted by numerous people. However, carers bear significant hidden costs of informal care, including the opportunity costs of lost earnings and health consequences of the physical and psychological burden experienced. Studies find that without adequate support, providing care may put informal carers at risk of poverty, ill health, and social isolation (Albin et al., 2016). In response, the first step involves recognising informal carers' contributions to society as this is the basis of official entitlements relating to financial support, employment regulations, and other social protections for carers. In Czechia, the government funded a national project to collect data on family carers, and their experiences and needs to raise awareness of informal care among families, employers, and local authorities (UNECE, 2019). Similar measures should be taken in China to gain a comprehensive understanding of the overall situation and needs of these unpaid carers to enable the management of care burdens and better tailoring of policies.

A great number of informal carers have full-time jobs. The lack of flexibility in the workplace makes it difficult for employees to reconcile work with care duties. Providing more hours of informal care means limited time for carers to fulfil professional activities or meet their personal needs. Studies find that some carers even decide to leave paid employment to provide round-the-clock care due to the combined stress derived from work and care and the lack of appropriate support measures (Hoefman et al., 2019; Orbelly et al., 1993). Reducing or even quitting the job would result in a loss of income, which would be followed by reduced pension entitlements and other negative financial consequences (Casado-Marín et al., 2011). Financial burden occasionally escalates when carers cover the costs of care recipients' or their own health demands, such as health care costs. Considering this, care leave entitlement or a flexible working arrangement is a possible solution. In Canada, working carers can take compassionate care leave for up to 28 weeks in a 52-week period to care for a family member who has a serious medical condition with a high risk of death within 26 weeks (UNECE, 2018). In France, working carers can apply for familial solidarity leave, which allows them to take time off work to care for family members who are unable to care for themselves. This leave can last up to three months and can be renewed. It cannot be deferred or denied by the employer. During this time, the carers can keep their position and rights in the company and receive benefits from the daily home support allowance paid by social security (Legal and Administrative Information Directorate, 2021). Furthermore, some working carers may apply to change their working hours or location to provide care more flexibly while juggling their work and care roles as well as their personal lives (Colombo et al., 2011). Although similar policies have been implemented in China, studies find that some companies either directly refuse employees' requests to care for their parents without pay, agree to their requests but do not provide social security support, or prevent them from being promoted, which eventually leads to them losing their jobs (Jiang, 2013). Under such circumstances, the importance of strengthening policy implementation supervision cannot be overstated as effective supervision is required for policies to function properly.

Care allowance is another way to provide financial support to carers. Some countries provide attendance allowances to care recipients to purchase social care services, which can be interpreted as an indirect acknowledgement of the family carer's involvement. In Belgium, the Personal Assistance Budget gives older people with disabilities the possibility to access formal support from personal assistants in their homes, leading to less dependency

on family members (UNECE, 2019). The Chinese government is also making a substantial effort in providing economic subsidies. For example, the Beijing government provides monthly service vouchers valued at RMB100 ($14.73) to older people aged 80 and above with disabilities (Zhou and Walker, 2016). With these vouchers, they can buy several services from registered service providers—including meals, baths, haircuts, and housekeeping—and thus depend less on informal care. However, few older people are eligible for government assistance due to the stringent eligibility requirements.

Some countries provide care allowance directly to carers who care for persons with critical needs. For example, in Ireland, informal carers can also receive an allowance to provide full-time care. This allowance is paid for an additional 12 weeks following the death or admission of an older person to institutional care; this is because when the carer's role ends, they require a transition period during which they can adapt to—and plan for—their life after caregiving (Rhee et al., 2015). In the UK, informal carers could be entitled to a range of cash benefits, including an allowance, a premium, and universal credit. The carer's allowance—a non-contributory, non-means-tested benefit paid to people who care full-time for someone who is severely disabled—is worth £67.60 ($82.91) a week for 2021–2022. The carer's premium—payable with means-tested benefits, such as income support, pension credit, and housing benefit—is worth £37.70 ($46.24) a week for 2021–2022. Universal credit—replacing means-tested benefits for working-age people—is worth £163.73 ($200.81) a month for 2021–2022 (Fernández et al., 2007; Foley et al., 2021; Moran et al., 2013). Similar policies can also be found in China. For instance, the Nanjing government began providing economic subsidies for family carers in late 2014. Family carers who take care of older people with economic difficulties—or with a moderate or severe level of impairment—can apply for the subsidies. The subsidy level depends on the condition of the older person. Specifically, family members who take care of older people having a moderate level of impairment can apply for RMB300 ($44.19) per month, while those taking care of older persons with a severe level of impairment can apply for RMB400 ($58.92) per month (Du, 2015). However, the amount of subsidies is still insufficient to cover the daily costs of carers, and greater cash benefits are required.

Accessible and affordable support services in the community are necessary to relieve informal carers from the burden of performing most care duties alone. In the U.S., the government funds the Lifespan Respite Care Program to provide respite care services for

family carers (Schulz and Eden, 2016). Numerous volunteers and paid respite care providers are being trained to increase the availability of professional services to provide high-quality care. In Finland, the government not only provides the statutory right to two days of respite per month for informal carers but also provides health checks (Lamura et al., 2019; Spasova et al., 2018). Empirical evidence shows that carers' burdens will be reduced and health status will improve after older people receive home care (Phetsitong and Vapattanawong, 2022). However, the number of community centres and professional services is limited in China, especially in less developed areas (Sun et al., 2021), and there is still a long way to go to relieve the burden on family carers.

Counselling services and access to training also help informal carers relieve their burden. In Germany, the government provides a counselling hotline for family carers, where they can obtain information and advice on their entitlements (e.g., care leave), benefits (e.g., income support), as well as support services (e.g., respite care) (Merkle, 2018). In the U.S., the government implemented the Strengthening the Financial Literacy and Preparedness of Family Carers Program in 2018, which offers practical skills training programs to family carers (e.g., bathing older adults in bed) (UNECE, 2018). This can help carers provide care more efficiently while also protecting them from the negative effects of caring on their income, health, and well-being. Such measures are worth considering to increase the sustainability of informal care in the future. By contrast, limited counselling services and training programs are available for family carers in China (Du, 2015). More counselling service centres and training programs are necessary to provide useful information on coping strategies, available support services, and entitlements and benefits to reduce carers' stress and burden.

9.3.3 Policy recommendations for health care

This thesis finds that older people with lower income, who receive less and lower quality informal care, do not have a higher probability of using health care. This does not imply that low-income groups do not require health care; rather, it suggests that those in need of health care may be unable to obtain it due to accessibility and affordability barriers. A policy approach to address these inequalities might be to improve equitable access and fairness in finance among low-income groups, for example, by ensuring their enrolment in health insurance programs. The government may consider free enrolment for low-income

households. Additionally, compared with OOP expenses for UEMI, those for urban non-employed and self-employed under URMI and rural residents under NRCMI are much higher and more likely to lead to higher health expenses (Tan et al., 2018). There is an urgent need for the government to enhance fiscal funding and benefit packages, for example, lowering its eligibility threshold, expanding coverage to more serious diseases, capping OOP expenses for people who are extremely poor, or linking benefit eligibility and packages to household disposable income rather than an absolute threshold. The medical insurance system should serve as an effective safety net for socioeconomically disadvantaged groups.

Additionally, this thesis implies that informal carers act as enabling agents of older people to help them stay in the hospital for a longer period of time for professional care. Some older people and their family members view the hospital as their only source of professional treatment, resulting in longer hospital stays and higher medical care costs. In such cases, the Chinese government should transform the current fragmented health care delivery system into an integrated care system to reduce some unnecessary patient concentrations in hospitals and relieve hospital burden (Yip and Hsiao, 2014). Some local governments, such as those in Beijing and Shanghai, integrate a tertiary hospital with several community health centres to reduce overcrowding at tertiary hospitals by redirecting patients to a lower level facilities. However, there are several obstacles to ensuring the sustainability of integrated care. Some community health care providers are undereducated and lack care knowledge and skills (Qian et al., 2017). They are less likely to receive comprehensive professional training, and a majority of them only provide services in daily activities and not medical treatment. Another issue is the lack of essential medical equipment and rehabilitation devices, which means that older people must visit the hospital for treatment and rehabilitation, resulting in unnecessary care costs (Meng et al., 2019). The lack of integrated health information systems further makes it difficult to achieve patient information, and facilitate patient referrals and follow-ups (Qian et al., 2017). Therefore, improving communities' capacity to provide daily care, chronic disease management, rehabilitation, and health education and counselling is essential to increase the frequency of patients' use of community health services.

9.4 Limitations

When considering the findings and policy implications of this thesis, noting the limitations is critical. They are divided into two categories: data source and methods.

In terms of data source, the first limitation is data representativeness. The CLHLS dataset is the first national dataset that includes the largest sample of the oldest-old aged 80 and over, as well as a compatible sample of younger-old people aged 65–79. However, it includes only half of the counties and cities of the 22 provinces with the sampling process as follows: for each centenarian, one nearby octogenarian aged 80–89 and one nearby nonagenarian aged 90–99 with pre-designed age and gender were matched and interviewed (Zeng, 2012). Although the CLHLS research team tried to have approximately equal numbers of male and female older people at each age, they did not use proportional sampling to avoid the errors of random fluctuation due to a sample size that is too small at more advanced ages, especially for males in urban or rural residences (Zeng, 2012). Consequently, sampling weights should be used to calculate mean or distribution of variables to make data represent of the whole older-adult population in the sampled provinces. On the other hand, weights may not be required when performing regression analysis from a causal nature, as the objective is not to obtain a representative estimate, but to evaluate causal associations.

Another concern is selective attrition, a common problem in all longitudinal surveys. Typically, studies use attrition weights in order to address selective attrition by observed characteristics. Unlike several international datasets, such as the English Longitudinal Study of Ageing, that provide both cross-sectional and longitudinal weights to data users, the CLHLS does not provide longitudinal weights. Many studies have shown that these datasets are reliable and sample attrition is unlikely to significantly affect the results (Zeng, 2012), therefore, attrition is not a major problem in the study.

Another limitation is the lack of more detailed information on informal care: As mentioned earlier in the empirical chapters, the question on informal care is a two-tier question. The respondents are first asked whether they required assistance in executing either item of ADLs; if they report that they did, they are asked to choose their primary carer. Consequently, the definition of informal care is conditional on reporting an ADL as measured by Katz's ADL index (Katz et al., 1970), and does not include help received for other type lf

limitations, such as IADLs, or other types of support, such as intergenerational financial transfer. This definition should be noted when considering the findings and implications of this thesis. For example, the findings on income-related inequalities in ADL assistance and its effects on health may not be generalisable to other types of assistance.

Respondents have only one option for the choice of primary carer, and this thesis does not distinguish between those receiving both informal and formal care and those receiving only informal care. In response to the rising demand for social care and the decline in potential family carers, the Chinese government has exerted a significant effort to provide home- and community-based care, such as meal and day care services. The number of older people relying on both informal and formal care has been rising in provincial capitals or large cities since 2012. However, this may not be a major issue for current analysis because research indicates that the proportion of older people receiving mixed care is very small, with approximately 95% of older people living at home with ADL limitations being cared for solely by family members (Hu and Ma, 2018; Peng and Wu, 2020).

Information on the hours of informal care is another issue. This survey only collects information on the hours of informal care provided by children or grandchildren and their spouse, rather than spouse, siblings, other family members, and friends, which might be important in understanding inequalities in the receipt of care. The findings of this thesis may not be generalised to the inequalities in hours of informal care from other sources.

An important limitation is the lack of certain types of information. Some studies use both income and wealth to measure financial resources (Floridi et al., 2020). Wealth captures the cumulative effects of lifetime advantages and disadvantages with respect to material resources, but the CLSHS survey provides limited information on financial assets, such as house value. Thus, the results of inequalities measured by household per capita income should be interpreted with caution. Similar issues arise when using health care information. This survey collects data on both outpatient and inpatient care, but in this study, specific care services—such as routine physicals, complex surgeries, or rehabilitation services—have not been separated from the data. The third empirical chapter only reveals the impact of informal care on outpatient or inpatient care: however, it would be worth investigating how these findings might differ for specific types of health care using more disaggregated data.

Self-report bias is another limitation. Specifically, self-reported subjective measures, such as self-reported limitations in daily activities, may reflect systematic difference in reporting styles between socioeconomic groups. As the recall period of the health care costs variable is relatively long (12 months), self-reporting may result in underestimation or overestimation.

Another limitation is that I use hours of informal care to measure intensity. Notably, the intensity of informal care is a comprehensive indicator that cannot be easily measured by the number of hours. It may also be determined by the type and manner in which assistance is provided. For instance, the same hours of assistance with bathing and dressing may not reflect the same intensity, and the same hours of assistance with the same tasks of higher or lower quality may not reflect the same level of intensity. Findings regarding the intensity of informal care measured by hours should be interpreted cautiously.

Another limitation is that the CIs and the RE models provide a basic understanding of the distribution of informal care across different income groups, but it does not point to the causal mechanisms generating the association between income and informal care use. Other advanced quantitative methods should be considered to disentangle this causal relationship. On the other hand, documenting the magnitude of inequities in informal care provides important information on the dimension of the problem, and highlight inequalities to policy makers and society, and justifying political action to address inequities.

This thesis uses a lagged FE model to investigate whether changes in informal care receipt between waves 1 and 2 are associated with those in health outcomes between waves 2 and 3. This model is less susceptible to endogeneity, but it does not completely address reverse causation or omitted variable bias. Other advanced quantitative methods, such as the IV approach, are required to identify the causal mechanisms underlying the observed associations. I try to use the number of surviving adult children/daughters/sons as the instrument, but these are time-invariant instruments, making individual fixed effects models difficult to use.

This thesis uses quantitative methods to offer an overview of income-related inequalities in informal care receipt and its effect on health and health care. However, qualitative methods can significantly complement quantitative findings by providing more information about older people's and carers' perceived needs and perspectives. Using these methods, more

detailed information can be provided to explain our quantitative findings, for example, why low-income older people experience less pronounced health benefits from informal care.

9.5 Future research agenda

This thesis has raised some concerns about income-related inequalities in informal care receipt and its effect on health. Building upon the findings of the thesis, in this final section, I highlight the possible directions for future research and data collection on older people's LTC use and health.

The role of gender in informal care needs to be further explored. Compared to sons, daughters and daughters-in-law, are more likely to provide daily care to older parents (Yang et al., 2021). Some studies suggest that a daughter's emotional bond with her parents is much stronger than that of a daughter-in-law; thus, the effect of care received from a daughter may be more beneficial than that received from a daughter-in-law (Chen and Short, 2008). However, the patrilineal culture in China specifies that daughters-in-law have primary obligations to their husband's parents, which guides daughters-in-activities law's and relationship with their in-laws, potentially reducing the differences between daughters and daughters-in-law. Zhang and Harper (2022b) further find that influenced by the patrilineal culture, receiving informal care from sons (or daughters-in-law) is associated with better physical and mental health than from daughters (or sons-in-law), especially among older people who are rural parents, mothers, and those with less wealth. Further research on the effect of receiving informal care from different sources on health would be interesting.

In addition to children-provided care, care provided by a spouse is another important source of informal care for older people (Du et al., 2016). Another potential research agenda would be to examine the inequalities in spouse-provided care and its effects on health and health care, to assess whether low-income groups face disadvantages when receiving spouse-provided care. In the short term, informal care will continue to be the primary type of LTC in China. After obtaining a thorough picture of the distribution of informal care from these two main sources, policymakers can identify the neediest population and target formal care resources to serve them.

Existing research has focused on ADL limitations rather than those with IADL limitations — partly because those with ADL limitations would be considered severely disabled and eligible for assistance, and the CLHLS' definition of informal care focuses on family assistance in ADLs. However, difficulties with IADLs, such as shopping, washing clothes, or lifting a heavy bag, are more common among community-dwelling older people, and are also closely linked to independence. If the government focuses solely on assistance in ADLs, it may overlook numerous older people who have IADL limitations but not ADL limitations. Studies find that these individuals are also vulnerable and in desperate need of assistance, and their functional ability would deteriorate if they did not receive the necessary support from family members, thereby increasing the likelihood of health care costs (Schiltz et al., 2020). Consequently, obtaining information about family support in IADLs is important—for example, whether the respondents received help with IADLs or for how many hours the spouse, children, and grandchildren helped them with IADL tasks. The CIs and the RE models used in this study can be used to examine the distribution of family support in IADLs across different income groups. The lagged FE models and IV approach can be used to investigate the effect of family support in IADLs on health and health care among older people. These research findings would be helpful for policy makers to determine the target beneficiaries, e.g., low-income older people who have IADL limitations but lack family support, to provide them with public formal care services.

Since the Chinese population is rapidly ageing and the sustainability of informal care has challenged, the Chinese government will continue to provide formal home- and community-based care services to meet growing care needs. Following studies in Western countries (Floridi et al., 2020; García-gómez et al., 2015), it would be interesting to analyse inequalities in different combinations of care received by older people, e.g., only informal care received, only formal care received, and the combination of both (mixed care) in China in the future. However, the current survey does not distinguish between those receiving formal, informal, and mixed care. The survey should be updated along with the LTC development, including a question asking whether the respondents receive both informal and formal care in order to have a comprehensive picture of socioeconomic inequalities in LTC utilisation. Similar methods can be used to investigate how income gradients vary in the use of only informal care, only formal care, and mixed care; and how the inequalities in LTC use are related to older people's health and well-being. If wealth information is available in the survey, analysis

can also focus on wealth-related inequalities in LTC utilisation from a life-course perspective.

With population ageing and the rising prevalence of chronic diseases, preventive health care, such as regular physical check-ups and dental screening, is widely recognised as the most cost-effective health care services (Xu et al., 2019). Some studies show that with more help from family members, older people may adopt positive healthy behaviours, resulting in improved health status, reducing the need for preventive health care (Thoits, 2011). On the contrary, some studies suggest that informal carers act as agents of older people, encouraging older people to seek preventive health care frequently in order to address health issues before having any symptoms, helping older people to schedule the appointments, and assisting older people in gaining access to health care centres without barriers (Bonsang, 2009). Therefore, the survey should collection information about preventive health care, and it would be interesting to investigate the impact of receiving informal care on the use of preventive health care among older people using a similar conceptual framework and methods.

With the ongoing development of formal care services, another important issue to consider is the relationship between informal and formal care, such as the effect of introducing more formal care services on informal care and vice versa. In Western countries, the effect of informal care on formal care services used by older people has been extensively studied (Holly et al., 2010; Van Houtven et al., 2020); however, this effect has been scarcely discussed in the Chinese context. Studies indicate that informal carers are able to provide care with low-level skills, such as grocery shopping or housekeeping, but unable to provide care with high-level skills, such as nursing care (Bonsang, 2009). In the first case, informal care may serve as a substitute for formal home care by meeting older people's basic care needs, while professional formal care services compliment informal care by covering highly skilled care. The IV approach might be useful to examine the causal relationship between informal and formal care: the impact of informal care on formal care; the impact of formal care on informal care; whether these relationships differ according to type of formal care, e.g., domestic help or nursing care; and whether this relationship differs depending on older people's financial resources.

In Western countries where LTC is well-developed, older people are heavy users of health and LTC services, accounting for the largest part of health care and LTC spending. For

example, people over 65 are almost twice as likely to have a hospital stay or use formal home care services compared to people under 65 in England (Forder, 2009). Yet, in some Western countries, the LTC system is often organised and funded separately from the health care system, which may cause some issues, such as the duplication of services. In such cases, the relationship between LTC and health care has received a great deal of attention to better coordinate social care and health care. A growing number of studies has indicated that the utilisation of LTC will have an impact on the demand for health care and vice versa (Forder, 2009; Forder et al., 2019). However, no studies in China have attempted to address this question; this thesis focuses on the impact of informal care on health care due to the lack of information on formal care. Future research is necessary to investigate the relationship between formal care and health care and the role of socioeconomic inequalities in this relationship. Addressing the questions will assist policymakers in allocating resources more efficiently, such as transferring funds from the health services to the formal care sectors, and improving overall health outcomes for older people.

Finally, while China is used as a case study in this thesis, my findings can shed some light on other Asian and upper-middle-income countries with similar increase in population ageing and the demand for long-term care. For instance, in Thailand, where formal care services are still in their early development, informal carers are the primary source of LTC (Knodel et al., 2018). It would be interesting to use similar conceptual framework and methods to investigate socioeconomic inequalities in informal care receipt, and their effects on health and health care use among older people in these countries. Findings from this thesis could motivate these countries to pay more attention to inequities in LTC affecting low-income people who have functional limitations and who lack adequate informal support. This thesis is the first step in identifying the nature of the problem of inequities in LTC, which will contribute to develop policies to achieve equitable access to LTC and improve coordination between LTC and health care systems.

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Appendix A. Robustness check for income-related inequalities in informal care (Chapter 6)

Appendix A1. Random effects multinomial logistic regression models among older people with functional limitations [a]

	Receiving informal care [b]		Receiving formal care [c]	
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
LN (income)	0.979 (0.064)	0.967 (0.068)	1.639 (0.132) ***	1.632 (0.157) ***
>=3 limitations in ADLs	8.411 (3.189) ***	3.116 (4.716)	22.453 (8.836) ***	9.277 (15.423)
Ln (income) * >=3 limitations in ADLs		1.138 (0.222)		1.124 (0.236)
Need-related variables				
Age	1.049 (0.013) ***	1.049 (0.013) ***	1.070 (0.015) ***	1.070 (0.015) ***
Male	1.386 (0.306)	1.385 (0.306)	1.191 (0.294)	1.190 (0.294)
Self-rated health				
Bad	Ref	Ref	Ref	Ref
Fair	1.055 (0.270)	1.056 (0.271)	0.890 (0.253)	0.902 (0.253)
Good	1.058 (0.283)	1.062 (0.284)	0.943 (0.280)	1.081 (0.318)
Number of chronic diseases	1.121 (0.083)	1.121 (0.083)	1.152 (0.090) *	1.146 (0.088) *
Cognitive function scores	0.980 (0.012)	0.979 (0.012)	0.992 (0.014)	1.003 (0.014)
Non-need variables				
Education attainment				
No education	Ref	Ref	Ref	Ref
Elementary school	1.178 (0.361)	1.181 (0.362)	1.691 (0.555) *	1.735 (0.566) *
Middle school and above	1.387 (1.009)	1.390 (1.012)	3.749 (2.796) *	4.012 (2.984) *
Marital status				
Married	Ref	Ref	Ref	Ref
Widowed	1.337 (0.377)	1.334 (0.376)	1.390 (0.453)	0.235 (0.041) ***
Other	0.338 (0.169) **	0.337 (0.168) **	0.545 (0.367)	0.462 (0.118) ***
Place of residence				
City	Ref	Ref	Ref	Ref
Town	1.459 (0.457)	1.461 (0.458)	0.615 (0.207)	0.634 (0.207)
Rural	0.971 (0.237)	0.969 (0.237)	0.118 (0.033) ***	0.135 (0.037) ***
Co-residence with family members				
No	Ref	Ref	Ref	Ref

Yes	2.571 (0.673) ***	2.556 (0.669) ***	0.932 (0.281)	0.872 (0.256) ***
Number of surviving children	1.002 (0.053)	1.002 (0.052)	1.021 (0.059)	1.029 (0.058)
Financial assistance from children				
No	Ref	Ref	Ref	Ref
Yes	1.061 (0.290)	1.059 (0.289)	1.398 (0.423)	1. 408 (0.416)
Living in the community with care services				
No	Ref	Ref	Ref	Ref
Yes	0.993 (0.257)	0.993 (0.256)	1.357 (0.382)	1.283 (0.354) **
Year				
2005	Ref	Ref	Ref	Ref
2008	1.100 (0.284)	1.108 (0.284)	0.500 (0.142) **	0.500 (0.142) **
2011	0.989 (0.289)	0.992 (0.290)	0.395 (0.131) ***	0.396 (0.131) ***
2014	1.071 (0.367)	1.075 (0.368)	0.189 (0.077) ***	0.190 (0.077) ***
_cons	0.226 (0.304)	0.249 (0.339)	0.000 (0.000) ***	0.000 (0.000) ***
N	11,158	11,158	11,158	11,158

Notes: [a] Ref=reference. ADL = activities of daily living. *** p<0.01, ** p<0.05, * p<0.1. [b] Model 1 and 2 are results of receiving informal care from random effects multinomial logistic regression models. The reference category is receiving no care. [c] Model 3 and 4 are results of receiving formal care from random effects multinomial logistic regression models. The reference category is receiving no care. Cells represent odds ratio (standard error).

Appendix A2 Random effects linear models among older people with limitations who receive informal care in China [a]

Variables	Model 1	Model 2
Ln (income)	0.020 (0.009) **	-0.014 (0.012)
>=3 limitations in ADLs	0.774 (0.027) ***	0.783 (0.027) ***
Ln (income) * >=3 limitations in ADLs		0.068 (0.016) ***
Need-related variables		
Age	0.010 (0.002) ***	0.010 (0.002) ***
Male	-0.010 (0.029)	-0.008 (0.029)
Self-rated health		
Bad	Ref	Ref
Fair	-0.031 (0.033)	-0.029 (0.033)
Good	-0.010 (0.035)	-0.005 (0.035)
Number of chronic diseases	0.036 (0.009) ***	0.037 (0.009) ***
Cognitive function scores	-0.013 (0.001) ***	-0.013 (0.001) ***
Non-need variables		
Education attainment		
No education	Ref	Ref
Elementary school	-0.027 (0.039)	-0.025 (0.039)
Middle school and above	0.017 (0.083)	0.020 (0.029)
Marital status		
Married	Ref	Ref
Widowed	0.246 (0.042) ***	0.245 (0.042) ***
Other	0.499 (0.119) ***	0.498 (0.119) ***
Residence		
City	Ref	Ref
Town	-0.344 (0.038) ***	-0.343 (0.037) ***
Rural	-0.293 (0.033) ***	-0.295 (0.032) ***
Co-residence with family members		
No	Ref	Ref
Yes	0.219 (0.051) ***	0.210 (0.051) ***
Number of surviving children	0.007 (0.007)	0.007 (0.007)
Financial assistance from children		

No	Ref	Ref
Yes	0.016 (0.035)	0.019 (0.035)
Living in the community with care services		
No	Ref	Ref
Yes	-0.048 (0.032)	-0.050 (0.032) *
Year		
2005	Ref	Ref
2008	0.064 (0.033) *	0.066 (0.033) **
2011	0.016 (0.039)	0.004 (0.039)
2014	0.012 (0.046)	0.013 (0.046)
_cons	1.858 (0.181) ***	1.860 (0.181) ***
N	10,203	10,203

Notes: [a] Cells represent coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Appendix A3. Random effects multinomial logistic regression models among older people with functional limitations [a]

	Receiving informal care [b]		Receiving formal care [c]	
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
LN (income)	0.970 (0.066)	0.879 (0.094)	1.627 (0.133) ***	1.428 (0.190) ***
Limitations in ADLs	2.145 (0.274) ***	1.252 (0.517)	2.767 (0.362) ***	1.490 (0.668)
LN (income) * limitations in ADLs		1.074 (0.059)		1.084 (0.063)
Need-related variables				
Age	1.049 (0.013) ***	1.047 (0.013) ***	1.070 (0.015) ***	1.070 (0.015) ***
Male	1.386 (0.306)	1.405 (0.314)	1.146 (0.287)	1.143 (0.287)
Self-rated health				
Bad	Ref	Ref	Ref	Ref
Fair	1.055 (0.270)	1.115 (0.289)	0.971 (0.279)	0.973 (0.281)
Good	1.058 (0.283)	1.138 (0.306)	1.022 (0.306)	1.031 (0.309)
Number of chronic diseases	1.121 (0.083)	1.121 (0.084)	1.141 (0.091) *	1.142 (0.091) *
Cognitive function scores	0.980 (0.012)	0.984 (0.013)	1.001 (0.014)	1.001 (0.014)
Non-need variables				
Education attainment				
No education	Ref	Ref	Ref	Ref
Elementary school	1.178 (0.361)	1.152 (0.354)	1.691 (0.555) *	1.596 (0.526)
Middle school and above	1.387 (1.009)	2.778 (2.820)	3.749 (2.796) *	7.323 (7.528) *
Marital status				
Married	Ref	Ref	Ref	Ref
Widowed	1.337 (0.377)	1.326 (0.379)	1.390 (0.453)	1.345 (0.443) ***
Other	0.338 (0.169) **	0.310 (0.156) **	0.545 (0.367)	0.475 (0.322) ***
Place of residence				
City	Ref	Ref	Ref	Ref
Town	1.459 (0.457)	1.455 (0.459)	0.615 (0.207)	0.624 (0.211)
Rural	0.971 (0.237)	0.995 (0.247)	0.118 (0.033) ***	0.123 (0.035) ***
Co-residence with family members				
No	Ref	Ref	Ref	Ref
Yes	2.571 (0.673) ***	2.518 (0.663) ***	0.932 (0.281)	0.900 (0.273)
Number of surviving children	1.002 (0.053)	1.060 (0.291)	1.021 (0.059)	1.029 (0.058)

Financial assistance from children				
No	Ref	Ref	Ref	Ref
Yes	1.061 (0.290)	1.059 (0.289)	1.398 (0.423)	1.411 (0.429)
Living in the community with care services				
No	Ref	Ref	Ref	Ref
Yes	1.051 (0.257)	1.051 (0.278)	1.357 (0.382)	1.371 (0.395) **
Having medical insurance				
No	Ref	Ref	Ref	Ref
Yes	0.974 (0.235)	0.977 (0.235)	1.162 (0.307)	1.167 (0.308)
Year				
2005	Ref	Ref	Ref	Ref
2008	1.100 (0.309)	1.106 (0.310)	0.474 (0.145) **	0.476 (0.146) **
2011	0.962 (0.308)	0.968 (0.309)	0.357 (0.128) ***	0.358 (0.128) ***
2014	1.104 (0.417)	1.115 (0.422)	0.180 (0.080) ***	0.182 (0.080) ***
_cons	0.090 (0.123)	0.195 (0.422)	0.000 (0.000) ***	0.000 (0.000) ***
N	11,158	11,158	11,158	11,158

Notes: [a] Ref=reference. ADL = activities of daily living. *** p<0.01, ** p<0.05, * p<0.1. [b] Model 1 and 2 are results of receiving informal care from random effects multinomial logistic regression models. The reference category is receiving no care. [c] Model 3 and 4 are results of receiving formal care from random effects multinomial logistic regression models. The reference category is receiving no care. Cells represent odds ratio (standard error).

Appendix A4 Random effects linear models among older people with limitations who receive informal care in China [a]

Variables	Model 1	Model 2
Ln (income)	0.020 (0.009) **	-0.026 (0.016)
Limitations in ADLs	0.231 (0.008) ***	0.109 (0.035) ***
LN (income) * limitations in ADLs		0.016 (0.004) ***
Need-related variables		
Age	0.010 (0.002) ***	0.010 (0.002) ***
Male	-0.010 (0.029)	-0.011 (0.030)
Self-rated health		
Bad	Ref	Ref
Fair	-0.000 (0.034)	-0.029 (0.033)
Good	0.037 (0.036)	-0.005 (0.035)
Number of chronic diseases	0.030 (0.009) ***	0.037 (0.009) ***
Cognitive function scores	-0.008 (0.002) ***	-0.013 (0.001) ***
Non-need variables		
Education attainment		
No education	Ref	Ref
Elementary school	-0.052 (0.041)	-0.050 (0.040)
Middle school and above	-0.002 (0.085)	0.001 (0.086)
Marital status		
Married	Ref	Ref
Widowed	0.194 (0.042) ***	0.193 (0.043) ***
Other	0.452 (0.120) ***	0.453 (0.120) ***
Residence		
City	Ref	Ref
Town	-0.307 (0.038) ***	-0.307 (0.039) ***
Rural	-0.255 (0.034) ***	-0.256 (0.034) ***
Co-residence with family members		
No	Ref	Ref
Yes	0.204 (0.052) ***	0.196 (0.052) ***
Number of surviving children	0.003 (0.007)	0.004 (0.007)
Financial assistance from children		

No	Ref	Ref
Yes	0.016 (0.035)	0.019 (0.035)
Living in the community with care services		
No	Ref	Ref
Yes	-0.048 (0.032)	-0.050 (0.032) *
Having medical insurance		
No	Ref	Ref
Yes	-0.082 (0.031) ***	-0.081 (0.031) ***
Year		
2005	Ref	Ref
2008	0.111 (0.035) *	0.066 (0.033) **
2011	0.017 (0.045)	0.004 (0.039)
2014	0.021 (0.051)	0.013 (0.046)
_cons	2.697 (0.567) ***	1.860 (0.181) ***
N	10,203	10,203

Notes: [a] Cells represent coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Appendix B. Robustness check for protective effects of informal care receipt on health of older people (Chapter 7)

Appendix B1. The relationship between receiving informal care and health among older people in China

	Number of ADL limitations			**Depressive symptoms**		
Variables	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**
Care types						
Receiving no care	Ref	Ref	Ref	Ref	Ref	Ref
Receiving informal care	1.236 (0.023) ***	-1.117 (0.168) ***	-0.433 (0.351)	0.155 (0.128)	-0.469 (0.245) *	-0.967 (1.042)
Receiving formal care	1.454 (0.110) ***	-1.244 (0.343) ***	0.281 (0.782)	-0.324 (0.512)	0.459 (0.867)	-0.650 (2.419)
Care types* Income (ln)						0.059 (0.120)
Receiving no care*Income (ln)			Ref			Ref
Receiving informal care*Income (ln)			-0.077 (0.040) **			-0.001 (0.127)
Receiving formal care*Income (ln)			-0.207 (0.232)			1.161 (0.736)
Income (ln)	0.001 (0.006)	-0.013 (0.013)	-0.006 (0.014)	-0.017 (0.027)	0.052 (0.041)	0.047 (0.042)
Age						

65-80	Ref	Ref	Ref	Ref	Ref	Ref
80+	-0.006 (0.030)	-0.068 (0.077)	-0.066 (0.077)	0.061 (0.139)	-0.061 (0.241)	-0.063 (0.241)
Gender						
Female	Omitted	Ref	Ref	Omitted	Ref	Ref
Male	Omitted	-0.150 (0.042) ***	-0.151 (0.042) ***	Omitted	-1.145 (0.147) ***	-1.144 (0.147) ***
Education attainment						
Illiteracy	Omitted	Ref	Ref	Omitted	Ref	Ref
Elementary school	Omitted	0.010 (0.036)	0.008 (0.035)	Omitted	-0.402 (0.143) ***	--0.400 (0.144) ***
Middle school and above	Omitted	0.182 (0.075) **	0.178 (0.075) **	Omitted	-0.424 (0.303)	-0.422 (0.303)
Marital status						
Others	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	-0.051 (0.057)	-0.127 (0.129)	-0.129 (0.129)	-0.055 (0.265)	-0.187 (0.405)	-0.186 (0.405)
Married	-0.078 (0.057)	-0.010 (0.128)	-0.006 (0.128)	-0.494 (0.263) *	0.076 (0.401)	0.074 (0.402)
Residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	-0.048 (0.041)	0.298 (0.087) ***	0.295 (0.087) ***	0.571 (0.186) ***	0.071 (0.270)	0.073 (0.270)

Rural	-0.066 (0.041)	0.329 (0.089) ***	0.328 (0.089) ***	0.643 (0.190) ***	-0.055 (0.276)	-0.054 (0.276)
Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.101 (0.026) ***	0.016 (0.061)	0.014 (0.060)	-0.393 (0.122) ***	0.244 (0.191)	0.246 (0.190)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.071 (0.031) **	0.073 (0.068)	0.076 (0.068)	-0.104 (0.143)	0.371 (0.214) *	0.368 (0.214) *
Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.001 (0.026)	-0.040 (0.056)	-0.041 (0.056)	-0.219 (0.120) *	0.124 (0.174)	0.125 (0.174)
Self-rated health						
Bad	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.127 (0.024) ***	0.051 (0.057)	0.051 (0.056)	-1.355(0.109) ***	0.235 (0.175)	0.234 (0.175)
Good	-0.149 (0.025) ***	0.134 (0.059) **	0.136 (0.059) **	-2.419 (0.113) ***	0.551 (0.186) ***	0.550 (0.186) ***

Number of chronic diseases	0.014 (0.007) **	-0.017 (0.015)	-0.016 (0.015)	0.056 (0.032) *	-0.077 (0.048)	-0.077 (0.048)
Cognitive function scores	-0.029 (0.002) ***	-0.000 (0.005)	-0.000 (0.005)	-0.055 (0.008) ***	0.024 (0.014) *	0.024 (0.014) *
Number of ADL limitations		0.685 (0.129) ***	0.688 (0.129) ***	0.206 (0.055) ***	-0.066 (0.118)	-0.068 (0.118)
Depressive symptoms	0.009 (0.003) ***	-0.009 (0.006) *	-0.009 (0.006) *		-0.012 (0.027)	-0.011 (0.027)
N			4,477			

Notes: ADL= activities of daily living. FE= Fixed effects. Cells represents coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Appendix B2. The relationship between receiving informal care and health among older people in China

Variables	Number of ADL limitations			Depressive symptoms		
	FE model	**Lagged FE model**	**Lagged FE model with interaction**	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**
Receiving informal care	1.239 (0.024) ***	-1.466 (0.206) ***	-0.223 （0.284）	0.170 (0.130)	-0.399 (0.253)	0.227 (0.346)
Receiving informal care*Income						
Receiving informal care*Lowest quintile			Ref			Ref
Receiving informal care*Second quintile			-0.379 (0.180) **			1.274 (2.363)
Receiving informal care*Middle quintile			-0.806 (0.179) ***			0.741 (0.891)
Receiving informal care*Fourth quintile			-0.570 (0.177) ***			3.577 (4.469)
Receiving informal care*Top quintile			-0.448 (0.180) **			2.695 (2.807)
Income						
Lowest quintile	Ref	Ref	Ref	Ref	Ref	Ref
Second quintile	-0.005 (0.023)	-0.016 (0.052)	-0.032 (0.053)	-0.121 (0.109)	0.023 (0.156)	0.262 (0.467)
Middle quintile	0.034 (0.024)	-0.034 (0.056)	0.003 (0.057)	-0.323 (0.114) ***	0.363 (0.166) **	0.171 (0.178)

Fourth quintile	-0.010 (0.027)	-0.006 (0.063)	-0.001 (0.065)	-0.349 (0.123) ***	0.350 (0.187) *	0.203 (0.378)
Top quintile	0.000 (0.027)	-0.073 (0.063)	-0.036 (0.065)	-0.266 (0.127) **	0.223 (0.189)	0.174 (0.267)
Age						
65-80	Ref	Ref	Ref	Ref	Ref	Ref
80+	-0.016 (0.030)	-0.067 (0.081)		0.043 (0.139)	-0.051 (0.242)	-0.059 (0.242)
Gender						
Female	Omitted	Ref	Ref	Omitted	Ref	Ref
Male	Omitted	-0.132 (0.043) ***	-0.095 (0.090)	Omitted	-1.161 (0.149) ***	-1.155 (0.149) ***
Education attainment						
Illiteracy	Omitted	Ref	Ref	Omitted	Ref	Ref
Elementary school	Omitted	0.011 (0.035)	0.009 (0.035)	Omitted	-0.421 (0.145) ***	-0.400 (0.144) ***
Middle school and above	Omitted	0.165 (0.074) **	0.168 (0.073) **	Omitted	-0.479 (0.307)	-0.435 (0.306)
Marital status						
Others	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	-0.052 (0.057)	-0.110 (0.137)	-0.106 (0.137)	-0.052 (0.267)	-0.148 (0.408)	-0.167 (0.408)
Married	-0.072 (0.057)	-0.036 (0.135)	-0.024 (0.135)	-0.527 (0.264) **	0.148 (0.404)	0.112 (0.404)

Residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	-0.049 (0.041)	0.354 (0.093) ***	0.351 (0.093) ***	0.624 (0.189) ***	0.024 (0.273)	0.035 (0.273)
Rural	-0.069 (0.041) *	0.391 (0.095) ***	0.389 (0.095) ***	0.691 (0.192) ***	-0.131 (0.279)	-0.118 (0.279)
Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.095 (0.027) ***	0.028 (0.065)	0.029 (0.065)	-0.368 (0.124) ***	0.213 (0.193)	0.238 (0.193)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.069 (0.031) **	0.062 (0.072)	0.064 (0.072)	-0.116 (0.143)	0.385 (0.215) *	0.361 (0.215) *
Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.000 (0.026)	-0.057 (0.059)	-0.060 (0.059)	-0.234 (0.121) *	0.140 (0.176)	0.135 (0.176)
Self-rated health						
Bad	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.116 (0.024) ***	0.049 (0.060)	0.051 (0.060)	-1.365 (0.109) ***	0.224 (0.176)	0.221 (0.176)
Good	-0.139 (0.025) ***	0.147 (0.063)	0.152 (0.063) **	-2.419 (0.113) ***	0.524 (0.186) ***	0.530 (0.186) ***

Number of chronic diseases	0.014 (0.007) **	-0.011 (0.016)	-0.010 (0.016)	0.053 (0.032) *	-0.069 (0.048)	-0.072 (0.048)
Cognitive function scores	-0.029 (0.002) ***	0.002 (0.005)	0.002 (0.005)	-0.054 (0.008) ***	0.024 (0.014) *	0.025 (0.014) *
Number of ADL limitations		0.940 (0.157) ***	0.949 (0.159) ***	0.205 (0.055) ***	-0.127 (0.124)	-0.125 (0.125)
Depressive symptoms	0.009 (0.003) ***	-0.011 (0.006) *	-0.011 (0.006) *		-0.010 (0.027)	0.012 (0.036)
N			4396			

Notes: ADL= activities of daily living. FE= Fixed effects. Cells represents coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Appendix B3. The relationship between informal care intensity and health among older people in China

	Number of ADL limitations			Depressive symptoms		
Variables	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**
Hours of informal care (ln)	0.295 (0.054) ***	-0.293 (0.195)	-0.291 (0.210)	0.161 (0.128)	-0.807 (0.453) *	-0.563 (0.377)
Hours of informal care (ln)* Income (ln)						
Hours of informal care (ln) *Lowest quintile			Ref			Ref
Hours of informal care (ln)*Second quintile			0.238 (0.883)			1.825 (2.349)
Hours of informal care (ln)*Middle quintile			0.476 (1.007)			3.492 (4.879)

Hours of informal care (ln)*Fourth quintile			0.422 (0.930)			4.311 (4.826)
Hours of informal care (ln)*Top quintile			-0.043 (0.851)			3.257 (3.896)
Income						
Lowest quintile	Ref	Ref	Ref	Ref	Ref	Ref
Second quintile	-0.113 (0.248)	0.278 (0.739)	1.398 (1.455)	-0.124 (0.560)	0.314 (1.570)	0.869 (1.370)
Middle quintile	-0.016 (0.237)	0.205 (0.761)	0.797 (0.989)	-0.315 (0.536)	0.314 (1.570)	1.664 (1.462)
Fourth quintile	-0.311 (0.261)	0.050 (0.909)	1.037 (1.134)	0.124 (0.591)	1.367 (1.750)	1.011 (1.392)
Top quintile	0.028 (0.286)	-1.436 (0.900)	0.709 (0.982)	0.199 (0.646)	0.903 (1.658)	-2.129 (1.494)
Age						
65-80	Ref	Ref	Ref	Ref	Ref	Ref

80+	0.240 (0.386)	-0.491 (1.434)	-0.388 (1.549)	-0.708 (0.872)	3.752 (2.929)	3.762 (1.867) **
Gender						
Female	Omitted	Ref	Ref	Omitted	Ref	Ref
Male	Omitted	-0.150 (0.375)	-0.090 (0.488)	Omitted	-0.931 (1.100)	-2.595 (1.499) *
Education attainment						
Illiteracy	Omitted	Ref	Ref	Omitted	Ref	Ref
Elementary school	Omitted	0.176 (0.674)	-0.028 (0.576)	Omitted	1.488 (1.217)	3.214 (1.666) *
Middle school and above	Omitted	1.009 (0.835)	0.218 (0.399)	Omitted	0.000 (1.923)	0.704 (2.348)
Marital status						
Others	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	-0.220 (0.706)	1.914 (1.734)	3.431 (2.072) *	0.858 (1.593)	1.834 (1.745)	0.081 (1.121)
Married	0.015 (0.677)	2.650 (1.905)	1.85 (2.185)	-0.639 (1.529)	2.692 (1.786)	-1.344 (2.346)
Residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	-0.855 (0.395) **	-0.812 (0.780)	-0.939 (1.029)	0.313 (0.899)	1.332 (0.908)	0.965 (0.643)
Rural	-0.884 (0.390) **	-0.582 (0.747)	-0.617 (0.817)	0.356 (0.888)	-0.459 (1.433)	-0.042 (0.995)

Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.374 (0.313)	-0.718 (1.062)	-0.299 (0.925)	-0.016 (0.708)		1.964 (1.209)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.311 (0.376)	-0.432 (1.170)	-0.191 (1.177)	0.555 (0.850)	-1.987 (2.195)	-0.661 (1.586)
Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.124 (0.358)	0.288 (0.742)	0.620 (0.838)	-1.166 (0.806)	-0.303 (1.142)	-0.536 (1.491)
Self-rated health						
Bad	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.231 (0.205)	0.288 (0.742)	0.513 （0.664）	-0.529 (0.464)	1.208 (1.100)	2.475 (0.902) ***
Good	-0.414 (0.234) *	0.683 (0.499)	1.219 （0.496） **	-2.285 (0.514) ***	2.365 (1.011) ***	3.326 (1.864) ***
Number of chronic diseases	0.045 (0.058)	-0.076 (0.117)	0.135 (0.708)	0.273 (0.130) **	0.072 (0.124)	0.087 (0.253)

Cognitive function scores	-0.026 (0.013) **	0.024 (0.017)	0.065 (0.138)	-0.047 (0.029) *	-0.033 (0.055)	-0.008 (0.065)
Number of ADL limitations		0.670 (0.305)	0.845 (0.131) ***	0.236 (0.134) *	-0.824 (0.380) **	-1.080 (0.513) **
Depressive symptoms	0.046 (0.026) *	0.101 (0.038) ***	0.119 (0.172)		0.321 (0.247)	0.079 (0.172)
N	1,687					

Notes: ADL= activities of daily living. FE= Fixed effects. Cells represents coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Appendix B4. The relationship between informal care intensity and health among older people in China

	Number of ADL limitations			Depressive symptoms		
Variables	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**	**FE model**	**Lagged FE model**	**Lagged FE model with interaction**
Receiving intensive informal care	0.733 (0.158) ***	-0.287 (0.315)	2.475 (2.442)	0.424 (0.365)	-0.387 (0.786)	-6.917 (4.771)
Receiving intensive informal care* Income (ln)			-0.340 (0.300)			0.795 (0.572)
Income (ln)	-0.066 (0.062)	0.072 (0.113)	0.295 (0.231)	0.083 (0.138)	-0.639 (0.289) **	-1.161 (0.465) **
Age						
65-80	Ref	Ref	Ref	Ref	Ref	Ref
80+	0.392 (0.388)	-0.245 (0.760)	-0.099 (0.821)	-0.633 (0.866)	3.734 (1.980) *	3.079 (1.926)
Gender						
Female	Omitted	Ref	Ref	Omitted	Ref	Ref
Male	Omitted	-0.138 (0.754)	0.063 (0.668)	Omitted	-2.236 (1.333) *	-2.125 (1.326)
Education attainment						
Illiteracy	Omitted	Ref	Ref	Omitted	Ref	Ref
Elementary school	Omitted	0.211 (0.747)	0.075 (0.684)	Omitted	2.781 (1.492) *	2.962 (1.483) **

Middle school and above	Omitted	0.598 (1.064)	0.309 (0.951)	Omitted	-0.311 (2.204)	0.216 (2.192)
Marital status						
Others	Ref	Ref	Ref	Ref	Ref	Ref
Widowed	-0.146 (0.710)	2.555 (2.029)	4.098 (4.375)	0.852 (1.584)	-0.553 (1.657)	0.517 (1.347)
Married	0.024 (0.682)	2.515 (2.195)	2.005 (3.432)	-0.755 (1.520)	-0.703 (1.489)	0.783 (1.658)
Residence						
City	Ref	Ref	Ref	Ref	Ref	Ref
Town	-0.928 (0.395) **	-0.362 (0.993)	-1.041 (1.641)	0.315 (0.890)	0.982 (0.623)	1.241 (1.740)
Rural	-0.891 (0.391) **	-0.254 (1.146)	-0.821 (1.328)	0.426 (0.880)	-1.207 (2.328)	0.082 (1.148)
Living with family members						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.393 (0.312)	0.214 (0.533)	0.233 (0.567)	0.048 (0.699)	2.326 (1.294) *	1.965 (1.260)
Smoking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.251 (0.382)	-0.779 (1.535)	-0.423 (1.078)	0.565 (0.851)	-1.768 (2.257)	0.087 (2.034)

Drinking						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.084 (0.360)	0.309 (0.850)	0.335 (0.725)	-1.258 (0.800)	-0.442 (1.538)	-0.511 (1.580)
Self-rated health						
Bad	Ref	Ref	Ref	Ref	Ref	Ref
Fair	-0.336 (0.206)	0.466 (0.518)	0.121 (0.448)	-0.636 (0.460)	1.299 (1.323)	2.845 (1.360) **
Good	-0.501 (0.234) **	1.226 (0.520) **	0.893 (0.474) *	-2.419 (0.505) ***	2.718 (1.816)	3.955 (1.306) ***
Number of chronic diseases	0.070 (0.058)	-0.099 (0.121)	-0.061 (0.135)	0.276 (0.129) **	0.231 (0.308)	0.152 (0.301)
Cognitive function scores	-0.030 (0.013) **	0.021 (0.029)	0.015 (0.031)	-0.044 (0.028)	-0.060 (0.073)	-0.048 (0.071)
Number of ADL limitations		0.412 (0.428)	0.701 （0.552）	0.251 (0.131) *	-0.886 (0.511) *	-1.116 (0.524)
Depressive symptoms	0.050 (0.026_ *	0.049 (0.051)	0.030 (0.058)		0.114 (0.169)	0.113 (0.163)
N			1,687			

Notes: ADL= activities of daily living. FE= Fixed effects. Cells represents coefficient (standard error). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C. Robustness check for impacts of informal care receipt on health care utilisation of older people (Chapter 8)

Appendix C1. First-stage regression results before examining the impact of informal care on total health care use among older people

	Hours of informal care	
Variables	**Utilisation**	**Total health care expenditures [a]**
Number of surviving adult daughters	1.307 (0.457) ***	1.030 (0.362) ***
Age	0.262 (0.056) ***	0.245 (0.067) ***
Gender		
Female	Ref	Ref
Male	-1.206 (1.139)	-.235 (1.242)
Self-rated health		
Bad	Ref	Ref
Fair	2.074 (1.321)	2.728 (1.398) *
Good	2.543 (1.342) *	2.373 (1.410) *
Number of chronic diseases	1.427 (0.338) ***	0.883 (0.413) **
Number of ADL limitations	11.107 (0.490) ***	11.739 (0.980) ***
Cognitive function	-0.258 (0.083) ***	-0.309 (0.128) **
Smoking		
No	Ref	Ref
Yes	1.021 (1.167)	1.233 (1.228)
Drinking		
No	Ref	Ref
Yes	-0.818 (1.155)	-0.606 (1.156)
Household per capita income last year (Ln)	0.161 (0.305)	0.716 (0.278) ***
Education		
Illiteracy	Ref	Ref

Elementary school	-1.291 (1.243)	0.017 (1.237)
Middle school and above	-0.507 (2.854)	1.464 (3.370)
Marital status		
Other	Ref	Ref
Widowed	-0.491 (2.667)	-0.493 (3.136)
Married	-5.706 (2.660) **	-6.065 (3.102) *
Living with family members		
No	Ref	Ref
Yes	5.000 (1.251) ***	4.527 (1.247) ***
Money received from daughters and their spouse	-0.249 (0.144) *	-0.192 (0.210)
Having medical insurance		
No	Ref	Ref
Yes	1.039 (1.424)	0.810 (1.582)
Residence		
City	Ref	Ref
Town	-8.986 (1.393) ***	-8.773 (1.725) ***
Rural	-5.507 (1.370) ***	-5.526 (1.824) ***
N	4,157	2,493

Notes: [a] Amount of total health care expenditures conditional on having any. ADL= activities of daily living. Cells represent coefficient (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C2. First-stage regression results before examining the impact of informal care on outpatient care use among older people

	Hours of informal care	
Variables	**Utilisation**	**Outpatient care expenditures [a]**
Number of surviving adult daughters	1.258 (0.329) ***	1.038 (0.372) ***
Age	0.248 (0.056) ***	0.241 (0.067) ***
Gender		
Female	Ref	Ref
Male	-1.293 (1.150)	-0.047 (1.273)
Self-rated health		
Bad	Ref	Ref
Fair	1.998 (1.331)	2.432 (1.415) *
Good	2.394 (1.350) *	2.571 (1.437) *
Number of chronic diseases	1.382 (0.342) ***	0.833 (0.425) **
Number of ADL limitations	11.031 (0.492) ***	11.661 (0.986) ***
Cognitive function	-0.250 (0.084) ***	-0.332 (0.131) **
Smoking		
No	Ref	Ref
Yes	0.690 (1.175)	0.966 (1.244)
Drinking		
No	Ref	Ref
Yes	-0.012 (1.166)	-0.280 (1.165)
Household per capita income last year (Ln)	0.304 (0.311)	0.637 (0.274) **
Education		
Illiteracy	Ref	Ref
Elementary school	-1.111 (1.250)	-0.002 (1.261)

Middle school and above	0.036 (2.886)	0.825 (3.359)
Marital status		
Other	Ref	Ref
Widowed	0.570 (2.758)	-0.987 (3.304)
Married	-4.549 (2.758) *	-6.511 (3.266) **
Living with family members		
No	Ref	Ref
Yes	4.696 (1.265) ***	4.692 (1.258) ***
Having medical insurance		
No	Ref	Ref
Yes	0.092 (1.434)	-0.092 (1.613)
Residence		
City	Ref	Ref
Town	-8.678 (1.421) ***	-8.854 (1.743) ***
Rural	-5.108 (1.401) ***	-5.416 (1.853) ***
Money received from daughters and their spouse	-0.275 (0.146) *	-0.014 (0,034)
N	4,118	2,245

Notes: [a] Amount of outpatient care expenditures conditional on having any. ADL= activities of daily living. Cells represent coefficient (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C3. First-stage regression results before examining the impact of informal care on inpatient care use among older people

	Hours of informal care	
Variables	**Utilisation**	**Inpatient care expenditures [a]**
Number of surviving adult daughters	1.060 (0.370) ***	1.254 (0.572) **
Age	0.282 (0.058) ***	0.307 (0.106) ***
Gender		
Female	Ref	Ref
Male	-1.658 (1.193)	-2.790 (1.816)
Self-rated health		
Bad	Ref	Ref
Fair	1.634 (1.381)	3.705 (2.097) *
Good	2.564 (1.401) *	2.221 (2.046)
Number of chronic diseases	1.601 (0.352) ***	0.995 (0.544) *
Number of ADL limitations	11.023 (0.510) ***	11.419 (1.672) ***
Cognitive function	-0.280 (0.087) ***	-0.197 (0.229)
Smoking		
No	Ref	Ref
Yes	1.540 (1.226)	1.276 (1.905)
Drinking		
No	Ref	Ref
Yes	0.248 (1.205)	0.622 (1.743)
Household per capita income last year (Ln)	0.186 (0.318)	0.985 (0.386) **
Education		
Illiteracy	Ref	Ref
Elementary school	-0.665 (1.291)	0.167 (1.829) *

Middle school and above	-1.094 (2.992)	1.355 (5.062)
Marital status		
Other	Ref	Ref
Widowed	-0.299 (2.919)	-4.504 (5.693)
Married	-5.391 (2.911) *	-8.833 (5.729)
Living with family members		
No	Ref	Ref
Yes	4.473 (1.318) ***	4.622 (1.993) **
Money received from daughters and their spouse	-0.226 (0.151)	-0.036 (0.027)
Having medical insurance		
No	Ref	Ref
Yes	1.768 (1.510)	1.409 (2.505)
Residence		
City	Ref	Ref
Town	-10.201 (1.464) ***	-8.257 (2.513) ***
Rural	-6.746 (1.440) ***	-3.897 (2.649)
N	3,080	1,236

Notes: [a] Amount of inpatient care expenditures conditional on having any. ADL= activities of daily living. Cells represent coefficient (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C4. Impacts of informal care on total health care among older people (including those using formal home- and community-based care as the primary source of care)

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.011 (0.002) ***	0.067 (0.157)
Age	-0.002 (0.001) ***	-0.024 (0.004) ***
Gender		
Female	Ref	Ref
Male	-0.021 (0.014)	0.236 (0.081) ***
Self-rated health		
Bad	Ref	Ref
Fair	-0.024 (0.015) *	-0.137 (0.091)
Good	-0.048 (0.018) ***	-0.305 (0.086) ***
Number of chronic diseases	0.043 (0.010) ***	0.229 (0.025) ***
Number of ADL limitations	0.036 (0.009) ***	-0.054 (0.099)
Cognitive function	0.003 (0.002) *	0.019 (0.005) ***
Smoking		
No	Ref	Ref
Yes	0.007 (0.016)	0.127 (0.085)
Drinking		
No	Ref	Ref
Yes	0.012 (0.015)	0.003 (0.094)
Household per capita income	-0.000 (0.005)	0.077 (0.027) ***
Education		
Illiteracy	Ref	Ref

Elementary school	0.017 (0.030)	0.162 (0.133)
Middle school and above	-0.032 (0.037)	0.076 (0.220)
Marital status		
Other	Ref	Ref
Widowed	-0.000 (0.032)	0.204 (0.202)
Married	-0.047 (0.036)	0.623 (0.386) *
Living arrangement		
Living alone	Ref	Ref
Living with family members	0.060 (0.024) ***	-0.280 (0.191)
Having medical insurance		
No	Ref	Ref
Yes	0.001 (0.017)	0.045 (0.108)
Residence		
City	Ref	Ref
Town	-0.013 (0.034)	-0.285 (0.181)
Rural	-0.023 (0.032)	-0.335 (0.187) *
Utilisation/Expenditures in last wave	0.022 (0.035)	0.155 (0.063) **
Money received from daughters and their spouse	-0.011 (0.006) *	0.017 (0.023)
N	5,408	4,353

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C5. Impacts of informal care on outpatient care among older people (including those using formal home- and community-based care as the primary source of care)

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.010 (0.004) **	-0.024 (0.047)
Age	-0.002 (0.001) *	-0.013 (0.004) ***
Gender		
Female	Ref	Ref
Male	-0.019 (0.013)	0.105 (0.070)
Self-rated health		
Bad	Ref	Ref
Fair	-0.026 (0.014) *	-0.076 (0.078)
Good	-0.044 (0.019) **	-0.228 (0.074)
Number of chronic diseases	0.035 (0.009) ***	0.187 (0.023) ***
Number of ADL limitations	0.041 (0.007) ***	-0.040 (0.094)
Cognitive function	0.003 (0.002) *	0.012 (0.004) ***
Smoking		
No	Ref	Ref
Yes	0.002 (0.015)	0.190 (0.074) **
Drinking		
No	Ref	Ref
Yes	0.016 (0.015)	-0.050 (0.083)
Household per capita income	-0.003 (0.005)	0.039 (0.025)
Education		
Illiteracy	Ref	Ref

Elementary school	0.008 (0.027)	0.153 (0.119)
Middle school and above	-0.035 (0.035)	0.103 (0.230)
Marital status		
Other	Ref	Ref
Widowed	-0.000 (0.032)	0.204 (0.202)
Married	-0.047 (0.036)	0.623 (0.386) *
Living arrangement		
Living alone	Ref	Ref
Living with family members	0.075 (0.019) ***	-0.099 (0.168)
Having medical insurance		
No	Ref	Ref
Yes	-0.007 (0.016)	-0.046 (0.097)
Residence		
City	Ref	Ref
Town	-0.003 (0.036)	-0.275 (0.168)
Rural	-0.015 (0.034)	-0.342 (0.175) *
Utilisation/Expenditures in last wave	0.049 (0.057)	0.211 (0.069) ***
Money received from daughters and their spouse	-0.004 (0.002) **	-0.014 (0.027)
N	5,359	4,208

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C6. Impacts of informal care on inpatient care among older people (including those using formal home- and community-based care as the primary source of care)

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	0.011 (0.002) ***	0.027 (0.013) **
Age	-0.006 (0.001) ***	-0.018 (0.008) **
Gender		
Female	Ref	Ref
Male	0.051 (0.017) **	0.255 (0.144) *
Self-rated health		
Bad	Ref	Ref
Fair	0.019 (0.019)	-0.285 (0.156) *
Good	-0.054 (0.022) **	-0.143 (0.170)
Number of chronic diseases	0.039 (0.010) ***	0.171 (0.038) ***
Number of ADL limitations	0.008 (0.024)	-0.150 (0.086) *
Cognitive function	0.005 (0.001) ***	0.015 (0.010)
Smoking		
No	Ref	Ref
Yes	-0.014 (0.020)	0.148 (0.163)
Drinking		
No	Ref	Ref
Yes	0.002 (0.021)	0.217 (0.165)
Household per capita income	0.006 (0.006)	0.131 (0.045) ***
Education		
Illiteracy	Ref	Ref

Elementary school	0.005 (0.031)	0.378 (0.200) *
Middle school and above	-0.005 (0.051)	0.059 (0.374)
Marital status		
Other	Ref	Ref
Widowed	-0.000 (0.032)	0.204 (0.202)
Married	-0.047 (0.036)	0.623 (0.386) *
Living arrangement		
Living alone	Ref	Ref
Living with family members	-0.070 (0.037) *	-0.449 (0.316)
Having medical insurance		
No	Ref	Ref
Yes	-0.005 (0.022)	0.412 (0.204) **
Residence		
City	Ref	Ref
Town	0.010 (0.046)	-0.059 (0.182)
Rural	0.015 (0.049)	-0.029 (0.204)
Utilisation/Expenditures in last wave	0.060 (0.074)	0.276 (0.130) **
Money received from daughters and their spouse	0.003 (0.002)	0.010 (0.044)
N	5,177	1,950

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C7. Impacts of informal care on out-of-pocket payments in total health care among older people

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.011 (0.002) ***	0.036 (0.086)
Age	-0.002 (0.001)	-0.021 (0.005) ***
Gender		
Female	Ref	Ref
Male	-0.036 (0.018) **	0.076 (0.079) **
Self-rated health		
Bad	Ref	Ref
Fair	-0.031 (0.015) **	-0.091 (0.097)
Good	-0.054 (0.020) ***	-0.207 (0.086) **
Number of chronic diseases	0.037 (0.010) ***	0.197 (0.026) ***
Number of ADL limitations	0.042 (0.009) ***	-0.070 (0.108)
Cognitive function	0.003 (0.002) *	0.013 (0.004) ***
Smoking		
No	Ref	Ref
Yes	0.021 (0.019)	0.117 (0.084)
Drinking		
No	Ref	Ref
Yes	0.016 (0.016)	0.031 (0.087)
Household per capita income	-0.001 (0.005)	0.048 (0.025) *
Education		
Illiteracy	Ref	Ref
Elementary school	0.001 (0.026)	0.030 (0.124)

Middle school and above	-0.008 (0.047)	-0.099 (0.229)
Marital status		
Other	Ref	Ref
Widowed	-0.000 (0.032)	0.211 (0.202)
Married	-0.043 (0.036)	0.587 (0.386)
Living arrangement		
Living alone	Ref	Ref
Living with family members	0.053 (0.024) **	-0.261 (0.192)
Having medical insurance		
No	Ref	Ref
Yes	-0.005 (0.017)	-0.118 (0.118)
Residence		
City	Ref	Ref
Town	-0.006 (0.048)	-0.069 (0.216)
Rural	-0.017 (0.045)	-0.166 (0.233)
Money received from daughters and their spouse	0.007 (0.003) **	0.013 (0.009)
N	5,158	4,136

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C8. Impacts of informal care on out-of-pocket payments in outpatient care among older people

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.010 (0.004) **	-0.026 (0.049)
Age	-0.001 (0.001)	-0.011 (0.004) ***
Gender		
Female	Ref	Ref
Male	-0.032 (0.017) *	-0.012 (0.069)
Self-rated health		
Bad	Ref	Ref
Fair	-0.032 (0.015) **	-0.094 (0.084)
Good	-0.054 (0.022) **	-0.200 (0.074) ***
Number of chronic diseases	0.034 (0.009) ***	0.153 (0.026) ***
Number of ADL limitations	0.043 (0.009) ***	-0.016 (0.102)
Cognitive function	0.034 (0.009) ***	0.008 (0.004) **
Smoking		
No	Ref	Ref
Yes	0.006 (0.017)	0.182 (0.076) **
Drinking		
No	Ref	Ref
Yes	0.013 (0.016)	0.027 (0.080)
Household per capita income	-0.002 (0.005)	0.038 (0.023) *
Education		
Illiteracy	Ref	Ref
Elementary school	0.006 (0.027)	0.009 (0.103)

Middle school and above	-0.048 (0.041)	-0.154 (0.235)
Marital status		
Other	Ref	Ref
Widowed	0.027 (0.038)	0.043 (0.472)
Married	-0.020 (0.057)	-0.022 (0.921)
Living arrangement		
Living alone	Ref	Ref
Living with family members	0.070 (0.021) ***	-0.022 (0.161)
Having medical insurance		
No	Ref	Ref
Yes	-0.015 (0.016)	-0.174 (0.107)
Residence		
City	Ref	Ref
Town	0.007 (0.054)	-0.215 (0.194)
Rural	-0.007 (0.051)	-0.272 (0.204)
Money received from daughters and their spouse	0.049 (0.057)	0.211 (0.069) ***
N	5,158	4,003

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C9. Impacts of informal care on out-of-pocket payments in inpatient care among older people

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	0.009 (0.002) ***	0.020 (0.012) *
Age	-0.006 (0.001) ***	-0.019 (0.008) **
Gender		
Female	Ref	Ref
Male	0.035 (0.020) **	0.081 (0.145)
Self-rated health		
Bad	Ref	Ref
Fair	0.023 (0.023)	-0.143 (0.162)
Good	-0.045 (0.026) *	0.067 (0.181)
Number of chronic diseases	0.040 (0.010) ***	0.122 (0.040) ***
Number of ADL limitations	0.010 (0.031)	-0.181 (0.089) **
Cognitive function	0.004 (0.001) ***	0.010 (0.010)
Smoking		
No	Ref	Ref
Yes	-0.007 (0.022)	0.116 (0.171)
Drinking		
No	Ref	Ref
Yes	-0.006 (0.023)	0.124 (0.174)
Household per capita income	0.006 (0.007)	0.101 (0.048) **
Education		
Illiteracy	Ref	Ref
Elementary school	-0.009 (0.036)	0.274 (0.219)

Middle school and above	0.030 (0.061)	-0.125 (0.394)
Marital status		
Other	Ref	Ref
Widowed	-0.015 (0.042)	0.676 (0.798)
Married	0.075 (0.037) **	1.005 (1.464)
Living arrangement		
Living alone	Ref	Ref
Living with family members	-0.063 (0.049)	-0.808 (0.293) ***
Having medical insurance		
No	Ref	Ref
Yes	-0.007 (0.023)	0.365 (0.205) *
Residence		
City	Ref	Ref
Town	0.031 (0.064)	0.135 (0.210)
Rural	0.018 (0.065)	0.195 (0.250)
Money received from daughters and their spouse	0.060 (0.074)	0.276 (0.130) **
N	5,158	1,817

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C10

The two-part model assumes that the decision of seeking health care and the choice of how much to spend are two independent decisions, but these two decisions can be influenced by distinct but correlated observable and unobservable factors (O'Donnell et al, 2007). In latent variable form, the model is given by the following:

$$y_{ji}^{*} = X_{ji}\beta_j + \varepsilon_{ji} \qquad j = 1,2$$

$$y_i = \begin{cases} y_{2i}^{*} & if\ y_{1i}^{*} > 0 \\ 0 & otherwise \end{cases}$$

Assuming that the two error terms are jointly normally distributed, the model can be estimated by the Heckman two-step procedure. The first step involves estimating a Probit Model for the probability of non-zero expenditures, using the results to estimate the Inverse Mills Ratio (IMR) to correct for selection bias. In the second step of the model, the following is estimated:

$$y_i = X_{2i}\beta_j + \rho\sigma_2 \frac{\phi\left(X_{1i}\widehat{\beta_1}\right)}{\Phi\left(X_{1i}\widehat{\beta_1}\right)} + e_{2i}$$

Where ϕ ( ) and Φ ( ) are the standard normal probability density and cumulative density functions, respectively, ρ is the correlation coefficient between the errors, and σ_2 is the standard deviation of ε_{2i} ($\sigma_1 = 1$). The performance of the Heckman Selection Model depends on the collinearity between the IMR and the explanatory variables in the regression equitation, and this can be tested using a t-ratio test.

Appendix C11. Impacts of informal care on total health care among older people (Heckman Selection Model)

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.013 (0.002) ***	0.036 (0.083)
Age	-0.002 (0.001) *	-0.024 (0.004) ***
Gender		
Female	Ref	Ref
Male	-0.012 (0.013)	0.203 (0.081) **
Self-rated health		
Bad	Ref	Ref
Fair	-0.029 (0.014) **	-0.129 (0.097)
Good	-0.042 (0.017) **	-0.268 (0.099) ***
Number of chronic diseases	0.040 (0.010) ***	0.239 (0.044) ***
Number of ADL limitations	0.042 (0.006) ***	-0.000 (0.116)
Cognitive function	0.002 (0.001)	0.014 (0.004) ***
Smoking		
No	Ref	Ref
Yes	0.005 (0.015)	0.108 (0.082)
Drinking		
No	Ref	Ref
Yes	0.012 (0.015)	0.020 (0.098)
Household per capita income	-0.000 (0.004)	0.058 (0.024) **
Education		
Illiteracy	Ref	Ref
Elementary school	0.012 (0.026)	-0.014 (0.113)
Middle school and above	-0.032 (0.038)	0.067 (0.234)
Marital status		
Other	Ref	Ref

Widowed	-0.000 (0.032)	0.226 (0.202)
Married	-0.057 (0.036)	0.788 (0.386) **
Living arrangement		
Living alone	Ref	Ref
Living with family members	0.058 (0.020) ***	-0.215 (0.181)
Having medical insurance		
No	Ref	Ref
Yes	0.002 (0.016)	-0.066 (0.090)
Residence		
City	Ref	Ref
Town	-0.036 (0.033)	-0.442 (0.188) **
Rural	-0.047 (0.031)	-0.454 (0.203) **
Money received from daughters and their spouse	0.005 (0.002) **	0.009 (0.010)
N	5,158	4,136

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C12. Impacts of informal care on outpatient care among older people (Heckman Selection Model)

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	-0.010 (0.004) **	-0.023 (0.042)
Age	-0.001 (0.001)	-0.013 (0.004) ***
Gender		
Female	Ref	Ref
Male	-0.009 (0.013)	0.112 (0.072)
Self-rated health		
Bad	Ref	Ref
Fair	-0.028 (0.014) **	-0.097 (0.087)
Good	-0.040 (0.017) **	-0.244 (0.085) ***
Number of chronic diseases	0.035 (0.009) ***	0.207 (0.045) ***
Number of ADL limitations	0.044 (0.005) ***	0.037 (0.134)
Cognitive function	0.002 (0.001)	0.010 (0.003) ***
Smoking		
No	Ref	Ref
Yes	0.001 (0.015)	0.125 (0.072) *
Drinking		
No	Ref	Ref
Yes	0.012 (0.014)	-0.005 (0.085)
Household per capita income	-0.002 (0.004)	0.033 (0.020) *
Education		
Illiteracy	Ref	Ref
Elementary school	0.011 (0.026)	-0.007 (0.105)
Middle school and above	-0.040 (0.037)	0.089 (0.242)
Marital status		
Other	Ref	Ref

Widowed	-0.000 (0.032)	0.226 (0.202)
Married	-0.057 (0.036)	0.788 (0.386) **
Living arrangement		
Living alone	Ref	Ref
Living with family members	0.070 (0.018) ***	-0.062 (0.192)
Having medical insurance		
No	Ref	Ref
Yes	-0.004 (0.015)	-0.126 (0.101)
Residence		
City	Ref	Ref
Town	-0.026 (0.037)	-0.501 (0.188) ***
Rural	-0.037 (0.035)	-.0527 (0.205) ***
Money received from daughters and their spouse	0.005 (0.003) **	0.021 (0.010) ***
N	5,158	4,003

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C13. Impacts of informal care on inpatient care among older people (Heckman Selection Model)

Variables	Lagged model with IV approach	
	Utilisation	**Expenditures**
Hours of informal care	0.008 (0.002) ***	0.024 (0.011) ***
Age	-0.006 (0.001) ***	-0.026 (0.008) ***
Gender		
Female	Ref	Ref
Male	0.043 (0.018) **	0.255 (0.145) *
Self-rated health		
Bad	Ref	Ref
Fair	0.023 (0.021)	-0.207 (0.167)
Good	-0.042 (0.023) *	-0.129 (0.168)
Number of chronic diseases	0.041 (0.011) ***	0.218 (0.034) ***
Number of ADL limitations	0.008 (0.027)	-0.066 (0.079)
Cognitive function	0.004 (0.001) ***	0.012 (0.009)
Smoking		
No	Ref	Ref
Yes	-0.005 (0.020)	0.178 (0.160)
Drinking		
No	Ref	Ref
Yes	-0.002 (0.022)	0.279 (0.156) *
Household per capita income	0.005 (0.006)	0.076 (0.042) *
Education		
Illiteracy	Ref	Ref
Elementary school	-0.004 (0.032)	0.217 (0.192)
Middle school and above	0.013 (0.058)	0.305 (0.375)
Marital status		
Other	Ref	Ref

Widowed	-0.000 (0.032)	0.226 (0.202)
Married	0.139 (0.068) **	-0.287 (0.441)
Living arrangement		
Living alone	Ref	Ref
Living with family members	-0.062 (0.040)	-0.372 (0.322)
Having medical insurance		
No	Ref	Ref
Yes	-0.003 (0.022)	0.234 (0.196) *
Residence		
City	Ref	Ref
Town	0.014 (0.060)	-0.145 (0.246)
Rural	0.002 (0.064)	-0.086 (0.270)
Money received from daughters and their spouse	0.002 (0.002)	0.014 (0.016)
Wave		
2011	Ref	Ref
2014	0.059 (0.025) **	0.471 (0.159) ***
2018	0.152 (0.109)	-1.251 (0.189) ***
N	5,158	1,817

Notes: ADL= activities of daily living. Cells represent marginal effects (robust standard errors). *** p<0.01, ** p<0.05, * p<0.1.