Faculty of Social Sciences
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SOCIOECONOMIC STATUS AND HEALTH AMONG THE ELDERLY CHINESE PEOPLE

A LONGITUDINAL STUDY

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ACADEMIC DISSERTATION

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ABSTRACT

The association between socioeconomic status and health has been well studied. It has been found that people in higher social classes generally have better health and a lower mortality. However, it is still inconclusive whether the health advantage acquired by people with a higher socioeconomic status weakens in later life. Although empirical evidence in Western societies has revealed different age-related patterns of health inequality, little is known about the situation in China, which has the largest population of elderly people in the world. Recent studies in some industrialised societies also indicate that socioeconomic status is not only individual but also family level resource. In other words, the family's socioeconomic status affect the health of family members. However, few studies have been conducted in middle-income countries such as China. Unlike in Western societies, co-residence with children is still the main living arrangement among the Chinese elderly, and family members play a significant role in the provision of healthcare for them. Thus, it is reasonable to speculate that the socioeconomic status of family members is even more important in terms of maintaining the health of elderly people in China than it is in Western societies.

The main objective of the present study was to investigate the trajectories of health in later life by means of different indicators of socioeconomic status, and to assess whether, and if so how the socioeconomic status of family members affects the health and mortality risk of elderly people in China. The specific aim was to find out whether elderly people with a higher socioeconomic status have better physical and cognitive functioning at baseline and a lower rate of decline with age. A further aim was to assess the extent to which higher educational levels among spouses and offspring are associated with self-rated good health and a lower mortality risk among elderly people.

The data used in this study came from the Chinese Longitudinal Health and Longevity Survey (CLHLS) conducted in China in 2002-2011. The CLHLS produced the largest set of population-based survey data covering Chinese people aged 65 and over. It was based on internationally compatible questionnaires and yielded extensive information on socioeconomic status, family structure and background, living arrangements, daily activities, life styles, and health conditions.

The results indicate that elderly people with a higher socioeconomic status have generally better physical and cognitive functioning at baseline, but the higher status did not protect against a decline in functioning with age. High education and household income predicted better cognitive functioning but were not associated with activities of daily living (ADL) functioning at baseline. High income was related to better instrumental activities of daily living (IADL) functioning but had no effect on the rate of change in IADL.

Inadequate financial resources and unavailability of health services were mainly associated with poorer physical functioning at baseline. The findings also revealed an association between higher spousal education and a lower mortality risk among elderly people. Male elderly people living with a highly-educated child seem to have a lower mortality risk than those living with offspring educated to a low level. It was also found that elderly men and women with a low level of education but living with highly-educated adult children were more likely to report good health, although the interaction effect was only significant for females. Thus, the main effect of education on mortality among elderly males should be interpreted with caution because it may vary according to the education of co-resident children.

The findings attest to the importance of socioeconomic status, in particular access to financial resources and health care services, in maintaining physical functioning among elderly people in China. Furthermore, living with a highly educated spouse or child also plays a significant role in reducing mortality risk.

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Yang, L., Konttinen, H., Martikainen, P., Silventoinen, K. 2017. Socioeconomic status and physical functioning: a longitudinal study of older Chinese people. *Journals of Gerontology Series B- Social Sciences*. Epub ahead of print.

II Yang, L., Martikainen, P., Silventoinen, K., Konttinen, H. 2016. Association of socioeconomic status and cognitive function change among elderly Chinese people. *Age and Ageing* 45(5): 674-680.

III Yang, L., Silventoinen, K., Martikainen, P. Individual's socioeconomic status, spousal and children's education associated with self-rated health among elderly Chinese people. Submitted.

IV Yang, L., Martikainen, P., Silventoinen, K. 2016. Effects of individual, spousal and offspring socioeconomic status on mortality among elderly people in China. *Journal of Epidemiology*, 26 (11):602-609.

The publications are referred to in the text by their Roman numerals.

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1 INTRODUCTION

Populations are ageing at an increasing rate throughout the world, especially in developing countries. Although health deterioration is a natural ageing-related phenomenon, elderly people from different socioeconomic backgrounds face different health conditions and rates of decline (Adler and Ostrove 1999). Health analyses conducted among ageing people give society crucial information given the strong effects on potential needs for medical care and services. It is necessary to understand the factors that are related to the health of the elderly people in order to project and allocate related needs for social services in the future. The association between socioeconomic status and health has been well studied in both developed societies and middle-income countries such as China. Most research has demonstrated that people with a higher socioeconomic status generally have better health and a lower mortality risk than those in lower social strata in different social contexts (Bassuk et al. 2002, Khang and Kim 2005, Lahelma et al. 2004, Liang et al. 2000, Winkleby et al. 1992).

Studies in industrialised countries report that elderly people with a higher socioeconomic status tend to have better health at baseline and a slower rate of age-related decline over follow-up (Karlamangla et al. 2009, Kim and Durden 2007, Taylor and Lynch 2004, Wilson et al. 2009), although findings regarding social differentials in health change are more inconsistent. Numerous studies have investigated how socioeconomic status determines health conditions and mortality risk in China (Beydoun and Popkin 2005, Luo and Xie 2014, Yi et al. 2007, Zimmer and Kwong 2004). However, it is still not clear whether, and if so how socioeconomic status is associated with baseline-level health such as physical and cognitive functioning, and with the rate of change among China’s ageing population.

Unlike in Western societies, family-based care and support for the elderly people still prevail in China (Li et al. 2013). Chinese people have been influenced by Confucian “Xiao” (Filial piety, in Chinese "孝") for more than two thousand years (Fan 2006), which has been the major social and emotional force holding together the whole family (Zhan et al. 2008). Children are among the most important sources of not only social but also financial support among the elderly, co-habiting with offspring being the normal expression of this kind of culture (Zimmer 2005). It is therefore possible that the health of elderly people is dependent not only on their own socioeconomic status but also on the socioeconomic resources of family members (such as a spouse or offspring). It has been suggested that socioeconomic status is not only an individual-level but also a family-level phenomenon (Zimmer et al. 2007), and previous studies of Western populations have reported that a higher level of education among spouses and offspring is associated with better health and a lower mortality risk among the elderly (Brown et al. 2014, Friedman and Mare 2014, Jaffe et al. 2005, Jaffe et al. 2006, Martikainen 1995, Skalická and Kunst 2008, Spoerri et al. 2014, Torssander 2013, Torssander 2014). We speculate that such associations may also exist and might be even stronger in China than in Western societies.

Overall, although the association between socioeconomic status and health among the elderly is well established in developed societies, caution should still be exercised in generalising the conclusions given the huge differences between the Chinese and Western contexts. China has the largest ageing population in the world, and has witnessed huge improvements in socioeconomic conditions and epidemiological transition in recent decades (Cook and Dummer 2004, Yang et al. 2013).There is a lack of in-depth research on the association between socioeconomic status and both cognitive and physical functioning in China, as well as on how the socioeconomic resources of family members affect the health and mortality of the elderly.

The aim of this study, which is based on representative longitudinal survey data covering the years 2002-2011, is to enhance knowledge about socioeconomic inequality in physical and cognitive functioning among the elderly in China, and to provide up-to-date information on social disparities in health taking the socioeconomic status of individual and co-resident family members into consideration. The longitudinal setting and the proper use of advanced quantitative statistical methods also facilitated examination of socioeconomic differences on various levels as well as changes in physical and cognitive functioning as people age.

2 THEORETICAL BACKGROUND AND EMPIRICAL EVIDENCE

This chapter reviews the literature on the association between socioeconomic status and health conditions. The discussion in the first section covers literatures concerning the socioeconomic determinants of health; the relations between socioeconomic status and physical and cognitive functioning are reviewed in Chapter 2.2; and the focus in the third and final section is on the effect of spousal and children's socioeconomic status on the health of the elderly. Theories and empirical evidence are discussed in parallel.

2.1 SOCIOECONOMIC STATUS AND IT'S INDICATORS

Socioeconomic status reflects different aspects of social stratification in a society characterised by social inequality (Adler and Ostrove 1999). It has been demonstrated that social inequality is associated with health inequality (Kaplan et al. 1996, Kawachi et al. 1997, Matthews et al. 1999), and there is a large body of literature based on different methodology, data sets and indicators of social position and health indicating a strong association between socioeconomic status and health conditions (Bassuk, Berkman and Amick 2002, Chen and Miller 2013). People in the lower socioeconomic strata generally have a higher mortality risk and disease rates than those with a higher socioeconomic status (Howard et al. 2000, Kaplan and Keil 1993).

Socioeconomic status is a composite measurement of aspects such as educational attainment, occupation and income (Dutton et al. 1989). It is a multidimensional concept and the different dimensions affect health in different ways, particularly in later life. For instance, the effects of education and income are not interchangeable (Braveman et al. 2005). Educational attainment is an important indicator of socioeconomic status. It is usually acquired in early life, sorting people into different social positions, and in its nature relates more to knowledge and skills such as health-related know-how (Laaksonen et al. 2005). Formal education gives access to a set of cognitive resources with the potential to affect health (Berkman et al. 2014). It implies long-term exposure to a broad range of health-risk factors affecting the chances of being unemployed and the nature of job that is related to different working conditions and earnings (Ross and Wu 1996, Ross and Wu 1995).

Occupational status is strongly connected to social class defining different resources and psychological risks, influencing income and working conditions and thereby potentially affecting health (Shavers 2007). Working conditions in particular industries are also strongly associated with health (Berkman, Kawachi and Glymour 2014). With the decreasing demand for physical jobs, the association between psychosocial factors such as job strain, stress at work and health has been well studied. It has been suggested, for example, that a lower occupational class predicts poorer self-rated health, and that low job control explains part of the association (Schrijvers et al. 1998). Some occupational risk factors such as high psychological demands, a poor attitude and low levels of job control have also been associated with the risk of cardiovascular and coronary heart disease (Bosma et al. 1997, Karasek et al. 1981).

High income is directly associated with higher levels of economic and material resources, and thus also makes access to healthcare and advanced technology easier than among poorer people (Geyer and Peter 2000). An adequate income is strongly connected to material conditions such as the quality and type of housing, food, clothing and physical activities, all of which have direct implications for health (Berkman, Kawachi and Glymour 2014). Among the elderly, in turn, wealth in the form of financial assets is also considered a valid indicator of socioeconomic status in that it reflects the accumulation of financial assets over the entire life course (Robert and House 1996).

Figure 1 illustrates the pathways between the various socioeconomic determinants of health. Education, occupation and income are highly interrelated: educational attainment has a direct effect on both occupation and health; occupation is the main structural link between education and income; and income is affected by occupational class, and also affects the individual's health.

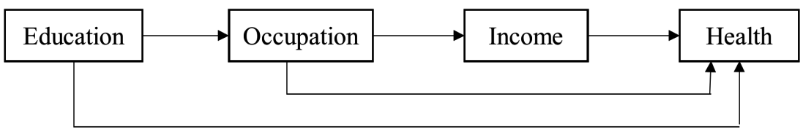

Figure 1. Pathways between socioeconomic status and health (Lahelma et al. 2004)

The socioeconomic gradient in health and its mechanisms

The existence of a socioeconomic gradient in health is well established in both industrialised and developing countries. Several theories have been put forward positing three mechanisms linking socioeconomic status to health outcomes. The first is material resources: people with a higher socioeconomic status tend to have more economic resources and thus better access to healthcare, especially preventative medical services (Blendon et al. 1989, Feinstein 1993). Material resources may affect health directly in influencing living conditions or other factors, or indirectly via certain healthy behaviours (Laaksonen et al. 2005). According to the theory of human capital, educated people are more likely to use their higher incomes to invest in their health (Mirowsky and Ross 2003). They are better able to apply their health-related knowledge and thus to understand and follow the instructions of health-service representatives (Lutfey and Freese 2005), and also benefit more from advanced medical technologies than those with a lower educational level (Chang and Lauderdale 2009, Glied and Lleras-Muney 2008).

The second mechanism comprises psychosocial factors such as social support, chronic and acute stress, and self-control and mastery (House et al. 1994, Williams 1990). Social support has been found to mediate the relationship between socioeconomic status and health. Individuals with a higher socioeconomic status are more likely to have higher levels of social support and larger social networks via marriage, family and friends (Luo and Xie 2014). Social support and networks are also beneficial to health in providing emotional support and advice (House et al. 1988). People may exchange health-related information or discourage unhealthy behaviours in their social networks and relationships, and thereby reduce their risk of early death (Berkman and Glass 2000, Cutler and Lleras-Muney 2010). It has also been reported in previous studies that people with a lower socioeconomic status have a higher risk of poor mental health and chronic stress, which affects their health (Everson et al. 2002). The prevalence of depression and mental disorders appears to be more profound in low-socioeconomic-status groups (Stansfeld and Marmot 1992). Cumulative physiological stress, known as the allostatic load, is linked to several health outcomes (Beckie 2012). A higher socioeconomic status increases the sense of personal control and mastery, and people with a higher level of personal control are more likely to change their health behaviour in a positive direction and to report good health (Mirowsky and Ross 1998, Mitchell et al. 2016, Pearlin et al. 1981, Wheaton 1980).

Health behaviour constitutes the third mechanism. Unhealthy lifestyles and habits such as smoking and excessive alcohol consumption, a lack of physical exercise and a poor diet explain much of the socioeconomic inequality in health and mortality: given their risky health behaviours, people with a lower socioeconomic status are more likely to have higher morbidity and mortality risks than those of a higher status (Graham 1996, Mejean et al. 2011, Pomerleau et al. 1997). Low levels of material resources and economic hardship have negative effects on cognitive control and self-regulatory capacity, easily leading to adverse health behaviours such as overeating, smoking, drug use and a low level of physical activity (Bogg and Roberts 2004, Buckley et al. 2014, Hagger 2010, Tarter et al. 2003).

It is noteworthy that none of the mechanisms described above is mutually exclusive: all three may well interact with each other to influence health. Long-term exposure to economic disadvantage is associated with a high level of stress, and goes on to affect the immune and cardiovascular systems, thereby increasing the risk of disease (Adler and Ostrove 1999). Psychosocial factors may have a more direct effect on health through inflammation markers, for example, but also work through health behaviours to some extent. Health behaviours may also be formed early in life, and may be associated with psychosocial disadvantage.

The life-course perspective

Recent studies on the associations between socioeconomic status and health among elderly populations in developed societies have increasingly adopted a life-course perspective. It is not only the current social circumstances of the elderly that affect their health, but also their childhood and adulthood socioeconomic status (Chen et al. 2006, Lynch et al. 1994). Although most studies report a positive association between socioeconomic status and health (Hardy et al. 2000, Lynch et al. 1994, Rahkonen et al. 1997), the evidence is still inconclusive as to whether this gap will persist throughout the ageing process. Previous studies have identified two distinct relationship patterns linking socioeconomic status and health with age: it has been found on the one hand that socioeconomic-status inequalities in health continue to diverge with age (Aneshensel et al. 1984, Miech and Shanahan 2000, Ross and Wu 1996), and on the other that they diverge until early old age and then converge (Beckett 2000, Elo and Preston 1996, House et al. 1994).

Two contrasting hypotheses have been proposed concerning life-course patterns of health inequality by socioeconomic status in later life: the cumulative advantage theory and the age-as-leveller theory. The cumulative advantage theory posits that the health advantage associated with a higher socioeconomic status accumulates throughout the life course, resulting in a larger socioeconomic-status-related health disparity in elderly compared to middle-aged adults (Ross and Wu 1996). According to the age-as-leveller theory, in turn, health gaps by socioeconomic status should diminish because of the increasing need for medical care and universal frailty in old age (Lynch 2003). There are also studies suggesting that those with a lower socioeconomic status are more likely to die before reaching old age, leaving a more robust group with a low educational level, and thus health convergence in older ages might result from mortality selection bias (Dupre 2007). The differences in health inequality found in previous studies may relate to the various age groups, and it is difficult to establish whether these differentials and the changes in them are analysed in relative or absolute terms. These inconsistent findings indicate a need for more research on increasing age-related socioeconomic disparity in health.

Several researchers have tested the two hypotheses, reporting different results. The cumulative advantage hypothesis was tested in one study on a cross-sectional and longitudinal dataset representing the US population. The findings supported the theory to some extent: gaps in self-rated and physical health increased with age between those with low as opposed to high educational attainment (Ross and Wu 1996). The findings from several other studies also support this hypothesis (Lauderdale 2001, Lynch 2003), and one study reported increasing inequality in mortality from middle to older ages in Canada, based on the Gini coefficient (Prus 2007).

Beckett (2000) tested the age-as-leveller theory taking mortality selection into consideration. According to his findings, sample selection bias could not explain the convergence in health inequality in later life (Beckett 2000). Kim et al. (2007) examined the age trajectories of physical and mental health by socioeconomic status using panel data on US adults, but the results somewhat contradicted the theory: education- and income-based gaps in physical health diverged for all adult groups, but income inequality in depression converged in later ages: it seems that age-related patterns in health trajectories may differ by different indicators of socioeconomic status and health (Kim and Durden 2007).

Recent studies in Finland have found that socioeconomic inequality in cause-specific mortality persists until very old age (90+ years), and better education and higher occupational status were associated with health advantage among nonagenarians (Enroth et al. 2013, Enroth et al. 2015). However, it was also found that cardoimetabolic (cholesterol levels, body mass index, and leptin) and inflammatory (C-reactive protein, interleukin-6, interleukin-1Ra) biomarkers mediated the association between education and physical functioning, and that among the oldest-old people educational differences in functioning decreased between the high- and low-educated (Enroth et al. 2016).

There has been little research on this issue in the Chinese context. Chen et al. (2010) found in their study that socioeconomic inequality in self-rated health diverged over the life course, thus supporting the cumulative advantage hypothesis (Chen et al. 2010). It was further reported in a study of socioeconomic differentials in mortality focusing on elderly Chinese people of 80 and over that socioeconomic inequality in health did not disappear altogether even among the oldest participants (Zhu and Xie 2007).

Previous research has produced empirical evidence supporting the hypotheses mentioned above. It should be pointed out that socioeconomic status and health are multifaceted indicators that are by no means homogeneous, and that the age-as-leveller and the cumulative advantage hypothesis may not apply equally to them all. The association between socioeconomic status and health may have different patterns in different social contexts, and hence there is a need for further study in the Chinese context given the wide differences in social conditions and healthcare systems between Western societies and China.

2.2 SOCIOECONOMIC STATUS AND FUNCTIONING

An individual's health is a vector of capacities to function in a set of domains range from hearing and seeing to moving around to cognition (Chatterji et al. 2015). Physical and cognitive functioning are two key indicators of functioning and are important for the quality of life, especially among the elderly. According to the International Classification of Functioning, Disability and Health (ICF) initiated by the World Health Organization (WHO,2002 version), the term "functioning" indicates all bodily functions, activities and participation, and these components interact with environmental factors such as architectural characteristics. Physical and cognitive functioning as health measures reflect both health conditions and the social and physical environment, the measurements varying slightly depending on the social context and the society, and involve interactions between the person and his or her environment.

A decline in physical and cognitive functioning among the elderly is a natural process associated with ageing. However, it has been found that elderly people varying in socioeconomic status seem to present various baseline levels and rates of change during the ageing process (Alley et al. 2007, Evans et al. 1997, Foubert-Samier et al. 2012, Taylor 2010, Xu et al. 2015, Zahodne et al. 2011). It has been found in previous studies that elderly people with a higher socioeconomic status tend to do better in terms of physical and cognitive functioning (Freedman et al. 2008, Lee et al. 2014), but whether or not socioeconomic status could help to slow the rate of age-related decline is far from clear. Socio-demographic characteristics such as age and gender also have an effect, and socioeconomic status has proven to be a strong predictor of physical and cognitive functioning. According to some studies, moreover, individuals with a lower socioeconomic status experience a faster decline (Anstey and Christensen 2000, Kim and Durden 2007, Taylor 2010), whereas others report no association between socioeconomic status and the rate of change in physical and cognitive functioning (Kelley-Moore and Ferraro 2004, Muniz-Terrera et al. 2009, Van Dijk et al. 2008, Xu et al. 2015).

Physical functioning

Despite the lack of well-established mechanisms linking socioeconomic status and physical functioning, several individual-level aspects such as biomedical, behavioural and psychosocial factors, the local-level or neighbourhood environment and childhood socioeconomic status may help to explain the socioeconomic disparity (Koster et al. 2006). Some biomedical factors, such as chronic diseases (cardiovascular disease and stroke, for example) and chronic under-nutrition are more prevalent in people with a lower socioeconomic status (Dalstra et al. 2005, Woodward et al. 2015). Long-term exposure to physiological stress mediators (cardiovascular, metabolic and immune systems) can cause a dysfunction in organ systems and then lead to various diseases (McEwen and Seeman 1999). Boult et al. (1994) found that some chronic conditions, such as cerebrovascular disease and arthritis, were predictors of the development of functional limitations (Boult et al. 1994).

Behavioural factors such as smoking and alcohol intake, obesity and physical activity have been associated with poor physical functioning. According to a study conducted in the UK, cigarette smoking, low levels of physical activity and unhealthy eating habits were associated with poorer physical functioning(Stafford et al. 1998), and Kim et al. (2013) found that protein-energy supplementation among elderly people with a low socioeconomic status helped to slow the progression of functional decline (Kim and Lee 2013). Besides, long-term overweigh or obesity were significantly associated with poorer physical functioning and later life functional limitations (Dowd and Zajacova 2015, He and Baker 2004). High level of physical activity was shown to be associated with better physical functioning and reduced the risk of ADL disability (Tak et al. 2013, Young et al. 1995).

Finally, it is acknowledged that psychosocial factors such as self-control, social support and depressed symptoms are related to physical health, and elderly people with a lower socioeconomic status tend to have lower levels of social support (Huurre et al. 2007). Previous studies report an association between a low level of social support and both poorer physical functioning and a high risk of physical disability (Mendes de Leon et al. 2001, Mendes de Leon and Rajan 2014). It has been shown that self-efficacy, indicating confidence in successfully engaging in specific behaviours, protects against functional decline among elderly people with low levels of functioning (Kempen and Ormel 1998), and that depression predicts a decline in physical functioning among elderly people (Penninx et al. 1998). Depressive symptoms such as feelings of hopelessness or anhedonia may reduce motivation and lead to harmful health behaviours (e.g., poor nutrition, smoking and a lack of physical activity) and inadequate appropriate preventive care and screening, cumulating in an increased risk of physical disability (Bruce 2001).

It is suggested in several studies that the local or neighbourhood environment and childhood socioeconomic characteristics may have an effect on physical functioning among the elderly. Neighbourhood environmental factors such as excessive noise, polluted air and poor access to public transportation have also been associated with an increased risk of decline in physical functioning (Balfour and Kaplan 2002). Moreover, living in neighbourhoods that are lower in socioeconomic status has been related to higher levels of strains and poorer physical functioning (Feldman and Steptoe 2004). An association has also been found between childhood socioeconomic status and later physical functioning: deprivation in childhood may cause continuous biological changes then and in later life, and this disadvantage may directly affect adulthood socioeconomic status with a further negative effect on health (Guralnik et al. 2006).

Cognitive functioning

Many studies have examined the association between socioeconomic status and cognitive functioning, particularly among the elderly. It has been found that cognitive functioning is related to both individual-level and community-level socioeconomic status (Clarke et al. 2012). Elderly people with a higher status maintain higher levels of cognitive functioning in later life than their counterparts with a lower status (Lee et al. 2003, Ott et al. 1999). Moreover, regardless of their socioeconomic status, individuals living in deprived areas are at greater risk of cognitive impairment than those living in more affluent areas (Basta et al. 2008).

The mechanisms linking socioeconomic status and cognitive functioning are not fully established. It is known from previous studies that different indicators of socioeconomic status have a varying impact on cognitive functioning, and the effects are not interchangeable. As far as the elderly are concerned, many studies have focused on the pathways of education, partly because it was the independent predictor of cognitive functioning. From a biomedical perspective, education in early life may help to improve brain functioning by increasing synapse numbers and density (Albert 1995, Katzman 1993). According to the cognitive reserve hypothesis, advantageous cognitive functioning among the highly educated will accumulate over the life course and delay the process of dementia (Stern 2003, Stern 2012). Having a higher education also enhances cultural competence and improves the ability to perform well in tests of cognitive functioning (Albert 1995, Alley, Suthers and Crimmins 2007).

With regard to the effect of income and occupation on cognitive functioning, fewer research has addressed this issue. For instance, it was found that the effect of wealth was largely attenuated after controlling for education (Cagney and Lauderdale 2002), but a low income still contributed to poorer cognitive performance (Lee et al. 2006, Turrell et al. 2002). A low occupational status has also been associated with a higher risk of dementia (Stern et al. 1994), and job complexity throughout working life has been associated with better cognitive functioning even when other indicators of socioeconomic status have been controlled for (Andel et al. 2007).

However, the evidence is still inconclusive as to whether a higher education protects against the rate of decline in cognitive functioning. According to some studies education helps to slow the rate of cognitive decline (Anstey and Christensen 2000, Glymour et al. 2012, Valenzuela and Sachdev 2006), whereas others suggest that a higher education has no protective effect (Muniz-Terrera et al. 2009, Van Dijk et al. 2008, Zahodne et al. 2011), or is even associated with an accelerated rate of decline in some domains (Alley, Suthers and Crimmins 2007).

Active cognitive reserve theory posits that spending more years in education could slow the rate of cognitive decline because the more highly as opposed to the less highly educated have greater cognitive reserves that may delay the clinical expression of cognitive diseases such as dementia by offsetting the cognitive expression of the pathology and tolerate more brain disturbance (Lee et al. 2006). Morever, it has been found that neurodegeneration associated with cognitive dysfunction had less immediate repercussions in highly educated people, who showed signs of dementia later than those educated to a lower level (Le Carret et al. 2003, Stern 2002).

Karlamangla et al. (2009) used US longitudinal survey data to assess the trajectories of cognitive functioning in later life, and found that educational level was not associated with the rate of decline in cognitive scores (Karlamangla et al. 2009). Gottesman et al. (2014) also found that educational level was not strongly related to 20-year cognitive change, and that elderly people with a lower educational level did not experience greater cognitive decline even when the effect of dropout was taken into account (Gottesman et al. 2014).

Alley et al. (2007) found that more years of education were associated with better initial cognitive tests and a lower rate of decline in cognitive status. However, elderly people with a better education experienced faster absolute decline in complex verbal and working-memory tasks than their less-highly educated counterparts (Alley, Suthers and Crimmins 2007).

Glymour et al. (2012), using random-intercept mixed models, found that a higher education predicted better cognitive performance and a slower decline in the Benton Visual Retention Test, the Trail Making Test B and the Mini Mental State Examination, but not in Isaacs' test of verbal/category fluency (Glymour, Tzourio and Dufouil 2012).

In sum, the effect of both physical and cognitive functioning on the quality of life in later years is strong, and socioeconomic factors play an essential role in maintaining such functioning among the elderly. Older people with a high socioeconomic status tend to have better physical and cognitive functioning, although the evidence is inconclusive as to whether a higher socioeconomic status slows the rate of decline with age not only in Western societies but also in China. Further research is warranted to investigate the extent to which a higher socioeconomic status might protect against the age-related rate of decline in physical and cognitive functioning.

2.3 SOCIOECONOMIC STATUS AND HEALTH

Health is a dynamic state of wellbeing characterized by the physical, mental and social potential that individuals can master to meet all the demands of their lives (Bircher 2005). It is "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" defined by the WHO. From the definitions above, health is a multidimensional concept, and at least four distinct dimensions could be identified: physical health, mental health, daily functioning and general well-being (Ware 1987). The importance of physical and cognitive functioning were discussed in the preceding chapter already. Self-rated health has been one of the most often used measures to indicate the general well-being of the elderly people (Molarius and Janson 2002). Self-rated health is a combination of subjective and objective health and has proved to be a good predictor of health and mortality among older adults (Heistaro et al. 2001, Yi, Gu and Land 2007). Mortality risk is a direct measurement for health. Socioeconomic disparity in self-rated health and mortality have been well studied both in the industrialized and developing societies, and generally people with higher socioeconomic status have better self-rated health and lower mortality risk (Laaksonen et al. 2005, Saydah et al. 2013, Signorello et al. 2014).

Previous studies on the associations between socioeconomic status and health in elderly populations have traditionally treated socioeconomic status as an individual-level indicator. However, it was found in an earlier study that in terms of education it is a household-level rather than a purely individual-level resource in Asian societies (Zimmer et al. 2007). Unlike in Western societies, family-based healthcare is still the main form of support for the elderly in China (Chen and Silverstein 2000, Zimmer and Kwong 2003). Abundant research on family support and health in relation to the elderly has been conducted in family-dominated settings in Asian societies (Samanta et al. 2015, Silverstein et al. 2006, Zimmer and Chen 2012). However, little is known about how the socioeconomic status of family member's affects the health and mortality of older people in China, although several studies have been carried out in Western societies (Brown, Hummer and Hayward 2014, Friedman and Mare 2014, Torssander and Erikson 2009, Torssander 2013). According to earlier research conducted in high-income societies, the educational attainment of one marital partner and his or her offspring have positive effects on both the health and the mortality of the other partner or parent (Friedman and Mare 2014, Spoerri et al. 2014, Torssander 2014). Elderly people with a highly educated spouse or children seem to have a lower mortality risk and better health, although they do not necessarily co-reside with their children.

Spousal education and the partner's health

Pathways linking the socioeconomic status of spouses and their offspring with the health of the elderly are fairly similar to those linking an individual's socioeconomic status and health. The status of a husband and wife mutually affects their health and mortality. Couples exchange material resources and emotional support to improve their health via marriage (Jacobson 2000). A partner with a higher as opposed to a lower socioeconomic status can contribute more to the family (Skalická and Kunst 2008), and a higher education in one partner is usually associated with a better occupation and a higher income on the individual level. Moreover, psychosocial factors such as social support, social networks, and stress brought in by household members also affect the health of the partner (Monden et al. 2003, Torssander and Erikson 2009). People with a low socioeconomic status generally have lower levels of social support and utilise social networks less effectively than their higher-status counterparts (Eckenrode 1983, Ross et al. 1990). The lifestyles that both partners bring into the family affect their respective health behaviours (Torssander and Erikson 2009). For instance, it has been found that dietary habits are associated with one's own and one's partner's smoking (Osler 1998). Spousal smoking behaviour also appears to relate to success in smoking cessation (Osler and Prescott 1998). A partner with a higher socioeconomic status tends to have a better lifestyle and health behaviour, which might help to discourage the other partner from pursuing an unhealthy lifestyle (Umberson 1992). Thus, one's own and one's partner's education affects one's lifestyle.

Previous studies also report gender differences in the association between spousal education and health. Men and women differ in the resources they accumulate via their spouse's education. Women appear to enjoy fewer health benefits from marriage than men (Wood et al. 2007). This may be because the economic resources that marriage brings are more beneficial to women, who tend to earn less than men: hence marriage brings different resources to men and women (Monden et al. 2003, Waite and Gallagher 2002). However, the protective effect of marriage is stronger for men than for women (Berkman and Breslow 1983, Litwak et al. 1989). Women are more likely to control other people's health, thus when they get married they tend to influence the health behaviour of their spouses, who in turn tend to feel the effects of health improvement relatively more strongly (Umberson 1992). Thus, men appear more likely to gain health benefits from psychosocial factors (e.g. lifestyle and health behaviours) via marriage, whereas women benefit primarily from the economic resources associated with their spouse's education (Brown, Hummer and Hayward 2014). However, there may be a selection effect in the gender difference of spousal education on health: it seems that men with higher incomes and better health are more likely to be married, and that single men are more likely to be thus selected on the grounds of poorer health.

According to a study conducted in the Netherlands using a sample of 25-74-year-olds, a partner's education was significantly associated with self-rated health and smoking status among males and females following adjustment for their own education. The authors claimed that the socioeconomic gradient in health would be underestimated if the partner's education were not taken into consideration, especially among females (Monden et al. 2003). It was further found in a Norwegian longitudinal study that the wife's education, but not occupation, was associated with ischemic heart disease and cardiovascular mortality among the men. As for the women, the husband's occupation was mainly related to ischemic heart disease and lung-cancer mortality, and men's income was a predictor of spousal stroke mortality. The effect of married women's education was stronger on elderly men, and the wife's occupation mattered more to middle-aged men: this may be attributable to the decreasing inequality in education between males and females, in other words, women with high education are highly selected group in older generations and these women stemmed from high status families (Skalická and Kunst 2008).

A Swedish register-data-based study on 30-59-year-olds examining the effects of spousal social position on mortality reported an independent association. The wife's education had a stronger effect on her husband's mortality possibly because women take the main responsibility for the family, and their healthy lifestyle could influence the food habits of the whole family (Torssander and Erikson 2009).

One study conducted in the US also attested to the importance of spousal education for the self-rated health of married adults, highlighting the impact of marriage on spousal health. Including spousal education in the model attenuated the association with the subject's own education and health, implying that failing to control for the former may overestimate the effect of the latter (Brown, Hummer and Hayward 2014).

A Swiss study conducted among married couples aged 30 and over examined the association of educational attainment with mortality and life expectancy using a population-based longitudinal sample. The results showed that having a spouse with a lower level of education was associated with increased mortality and decreased life expectancy. These effects varied by spousal education within individual education (Spoerri et al. 2014).

Children's education and parental health

Aside from the effect of spousal socioeconomic status on health among the elderly, previous studies also indicate that offspring's education may be a predictor of parental health and mortality: elderly people with highly educated children tend to have better health and lower mortality risk regardless of whether or not they live together (Friedman and Mare 2014, Torssander 2013). Most adults in Western societies do not live with their parents, which is not the case in Chinese society (De Jong Gierveld and Van Tilburg 1999), but this does not mean that they do not have material and emotional exchange. Adult offspring in the US are likely to support their parents in later life, and children tend to live fairly close to their parents (Lennartsson et al. 2009, Spitze and Logan 1990). Thus, offspring and their support constitute a significant part of their parents' social network.

Mechanisms explaining why the education of offspring has an effect on their parents' health and mortality are not well established yet. However, several studies have offered suggestions. One way in which children influence parental health is by providing direct healthcare (Friedman and Mare 2014): they have been reported to provide more than a third of the healthcare that elderly people need in the US (McGarry 1998). Highly educated children have more financial resources they can deploy to support their parents. Previous studies conducted in the US revealed that children with limited economic resources were less likely to help their parents, whereas adult children with a college degree were more likely to provide parental care (Hogan et al. 1993, McGarry and Schoeni 1995, McGarry and Schoeni 1997). Furthermore, offspring with a better education have better health knowledge and information, and thus can provide better healthcare to their parents. They could also have a significant effect on their parent's health by convincing them to change unhealthy behaviours (Friedman and Mare 2014). A second potential mechanism is social in the form of emotional and instrumental support (Torssander 2013). Emotional support from children is instrumental in helping the elderly to maintain their physical and mental health (Zunzunegui et al. 2001). It also helps to reduce parental stress related to formal healthcare and practice (Umberson 1987). Such help may be more beneficial to parents who have been widowed or are in dire need of assistance (Silverstein and Bengtson 1994).

Zimmer et al. (2007) examined the combined effect of the education of the elderly and their adult children on the mortality of the elderly using 14-year longitudinal survey data from Taiwan, a typical society with a Chinese culture. The results showed that the level of education of the children was associated with the mortality of the elderly, especially when the latter had reported a serious disease. It was also found that parents with a higher level of education could gain more health benefits if their children also had a better education: it may be that more-highly-educated elderly people are able to make better use of the resources their children provide (Zimmer et al. 2007).

Torssander (2013, 2014) studied the significance of adult children's socioeconomic status on their parents' mortality in the Swedish context. In her first study she found that children's education was significantly associated with their parents' mortality after controlling for the socioeconomic status of the latter. The second study extended the scope by incorporating the offspring's occupational class and income, and also examined cause-specific mortality risk in accordance with socioeconomic status. It seemed that the children's education was the key factor determining parental mortality compared with other indicators of socioeconomic status: the implication is that parents gain health advantages from non-material resources supplied by their children, such as health knowledge and information, regardless of the offspring's occupational status and economic returns in the labour market (Torssander 2013, Torssander 2014).

Friedman et al. (2014) tested such an association in the US and found a similar relation between children's education and parental mortality. The educational level of adult children had a significant effect on their parents' health, and this association was more pronounced in the case of death from chronic lower respiratory disease and lung cancer, diseases that are related more strongly to health behaviours. Adult children may have an impact on their parents' health behaviours such as eating habits, smoking and alcohol consumption through education that affects their own lifestyle and health behaviour (Friedman and Mare 2014).

In sum, there has been ample research in many Western societies on the associations of spousal and offspring's socioeconomic status with health among the elderly, and there is ample evidence to suggest that family members' financial resources have a significant effect. However, little is known about whether this association exists in Chinese society – a society in which co-residence of ageing parents with adult children is quite common. Further study is needed to investigate the effects of spousal and offspring's socioeconomic characteristics on the health of these elderly people.

Overall, there appears to have been little research on socioeconomic differences in the trajectories of physical and cognitive functioning focusing on elderly people in China. Moreover, there are few studies on the effect of family members' socioeconomic status on the health of the elderly. The population is ageing at a fast pace in China. Research on the extent to which individual and family members' socioeconomic status affects the health, mortality and rate of age-related change in physical and cognitive functioning would facilitate the allocation of healthcare services among elderly people, and would also provide valuable information to other middle-income economies in Asia.

3 THE AGEING POPULATION IN CHINA

China has achieved remarkable economic growth since the market-economy reforms and opening-up policy in the early 1980s. As a middle-income country it has shown rapid improvement in health conditions and undergone epidemiological transitions in the decades following the founding of The People's Republic of China in 1949. Crude mortality and infant-mortality rates have dropped continuously and strikingly (Chen, Yang and Liu 2010). However, health disparities also exist alongside the rapid economic growth. There is a clear gradient linking life expectancy and gross domestic product in different provinces: life expectancy was 78 years in Shanghai compared with 66 in the poorest province of Guizhou, for example (Tang et al. 2008).

China is currently the most highly populated country in the world in terms of both total population and the number of elderly people. The total population in 2014 was more than 1.36 billion (Chinese National Statistics Bureau, 2014). The demographic structure has changed since the implementation of the one-child policy in urban areas in the 1970s, and the rapid economic and societal development of recent decades. China has become an ageing society as a result of declining fertility and increasing life expectancy (Luo and Xie 2014). According to the National Sixth Population Census of 2010, the life expectancy of Chinese people was 74.83 years (72.38 years for males and 77.37 years for females). According to the projections of the United Nations, life expectancy will increase to 77.23 years for males and 80.0 years for females between 2025 and 2030, and to 81.66 and 83.37 years for males and females, respectively, between 2045 and 2050 (United Nations, 2015, see Figure 2). More importantly, the proportion of elderly people aged 65 and over increased from five per cent in 1990 to 8.2 per cent in 2010, and is expected to increase further to 17.2 and 27.5 per cent in 2030 and in 2050, respectively (United Nations, 2015, see Figure 3).

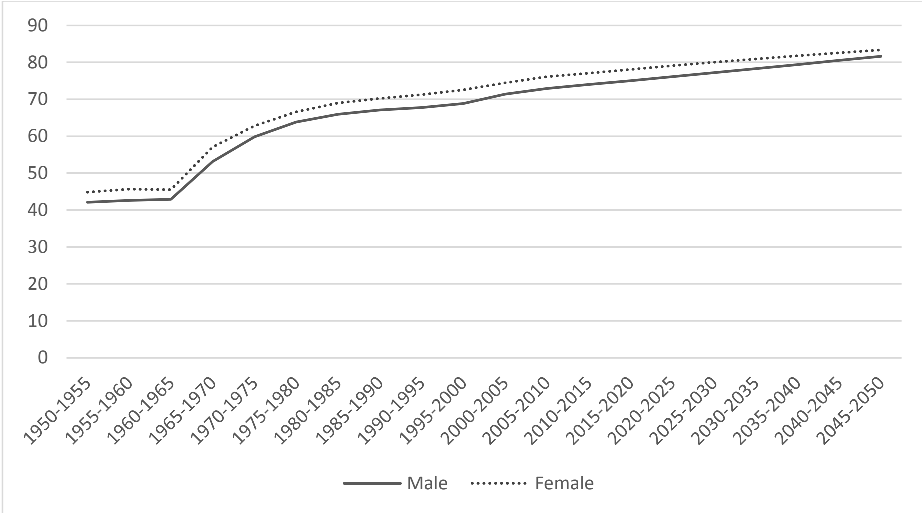

Figure 2. Past trends and projections of life expectancy in China, 1950-2050
Sources: United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: The 2015 Revision - Special Aggregates, DVD Edition. http://esa.un.org/unpd/ppp/.

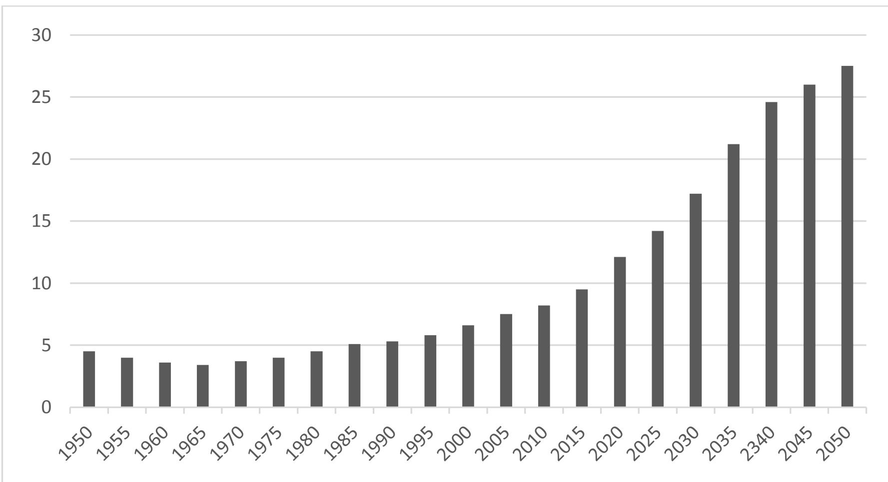

Figure 3. Past trends and projections of the proportion of the population aged 65 and over in China, 1950-2050
Sources : United Nations (2015). Probabilistic Population Projections based on the World Population Prospects: The 2015 Revision. Population Division, DESA. http://esa.un.org/unpd/ppp/.

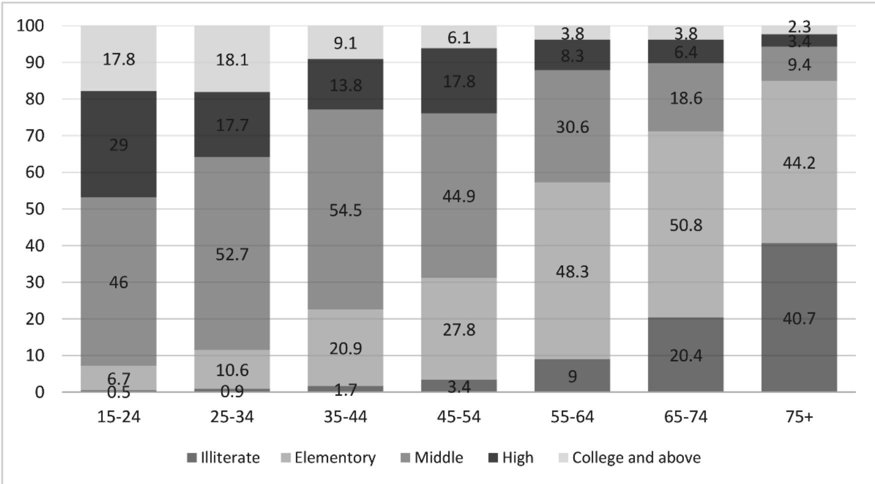

Figure 4. Proportions of Educational attainment in different age groups

Sources: The Sixth National Population Census, 2010. Chinese National Statistical Bureau

China has a unique ageing profile because it has the largest ageing population in the world while there are still large disparities in socioeconomic and societal development in different parts of the country (Lessmann 2014, Xie and Zhou 2014). Following the economic reforms in 1978 the eastern side led the development with its regional and policy advantages. Although the Chinese government has launched several development plans for the Northeast, the Middle and the Western parts of the country in recent decades, large disparities still exist. China is experiencing a rapid economic boom, but also a rise in health inequality. The widening disparities in health between those who have benefited from the economic growth and those who have been left behind, as well as between urban and rural populations are daunting (Meng et al. 2012). Inequality in educational attainment is increasing (Figure 4), for example: the proportion of people with an upper-secondary, college and university education decreases with increasing age, against an increase in the proportion of people with a low educational level. Thus, large disparities in the socioeconomic development of different regions along with rapid changes in the population structure are among the major challenges facing China in terms of societal and economic development.

4 THE AIMS OF THE STUDY

Previous studies investigating the associations between socioeconomic status and health have used various indicators based on varying datasets and methodology in both Western and non-Western social contexts. However, there are still large research gaps to be filled. Overall, it is unclear whether a higher socioeconomic status is associated with a lower age-related rate of decline in physical and cognitive functioning, particularly among China's elderly population. Furthermore, although the effects of family members' socioeconomic status on the health of the elderly have been well studied in high-income societies, it is still unclear whether this association exists in Chinese society. The aim of the present study is to narrow these research gaps through the analysis of extensive population-based longitudinal survey data on China.

The overall objective is to enhance understanding of and up-date existing research on the associations between socioeconomic status and health in the Chinese context, a society in which the notions of the family unit and filial piety are still dominant. By examining the association between socioeconomic status and the baseline level of physical and cognitive functioning, and applying the latent growth curve model and the selection model to study the respective trajectories of change during follow-up, the aim is to broaden the findings from previous studies. The nature and extent of any association between co-resident family members' education and the health and mortality of the elderly was also investigated, considering socioeconomic status as a family rather than an purely individual-level characteristic. Figure 5 describes the overall framework for the present study.

The specific aims of the study were as follows:

1. To find out whether socioeconomic status is associated with baseline levels and the rate of change in physical functioning measured in terms of Activities of Daily Living (ADL) and Instrumental Activity of Daily Living (IADL) (Sub-study I).
2. To find out whether socioeconomic status is related to the baseline level and the rate of change in cognitive functioning in accordance with the Mini-Mental State Examination (MMSE) (Sub-study II).
3. To find out a) how various individual socioeconomic-status indicators are associated with self-rated health, b) whether spousal and co-resident adult children's education is related to health net of these individual indicators, and c) whether these factors interact (Sub-study III).
4. To study the extent to which co-resident spousal and offspring's education are associated with mortality risk, and whether these effects vary depending on the subject's education (Sub-study IV).

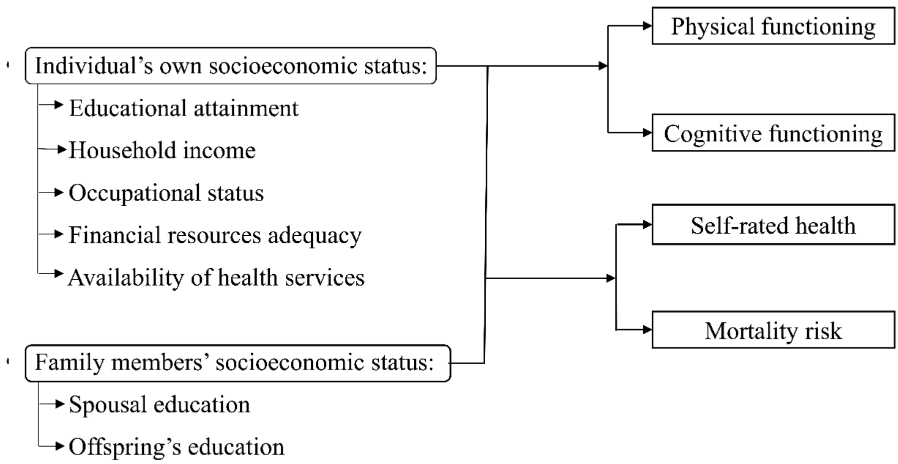

Figure 5. Study framework for the socioeconomic status and health among the elderly Chinese people.

5 DATA AND METHODS

5.1 DATA SOURCES AND STUDY DESIGN

The analyses of this study are based on the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which is a face-to-face survey conducted by the Centre for Healthy Aging and Family Studies at Peking University in China using internationally compatible questionnaires. The sample of Chinese elderly people was randomly selected from nearly half of the counties in 22 out of the 31 provinces of Mainland China. The 22 provinces covered 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 about 85 per cent of Mainland China's total population at baseline in 1998 (Shen and Zeng 2014). An interviewer and a nurse conducted the interviews and carried out a basic health examination at each interviewee's home for each phase. The survey contains extensive information on Chinese elderly people, including socio-economic indicators, family structure and background, living arrangements, daily activities, life styles and health conditions.

The baseline survey was initiated in 1998 among more than 8,900 elderly people aged 80 years and over, and follow-up surveys were conducted every three or four years. Younger elderly people aged 65-79 years were included from the year 2002, based on the same selection method as used for those aged 80 and over. An emphasis on data quality in the training of interviewers, a strict accountability system and careful post-checking for data quality ensured the high quality of the dataset. Accuracy with regard to age is very important in ageing and mortality studies. Most people in China, especially among the older generations, use the Chinese lunar calendar and animal year to remember their birthdays (Coale and Li 1991). Thus, the elderly and even the illiterate could provide reliable date-of-birth information. Permission to use the data was obtained from the Centre for Healthy Aging and Family Studies at Peking University, and the released dataset did not include any information that would identify individuals.

Sub-studies I and II were both based on the four sets of CLHLS data from the years 2002 to 2011. The aim was to study the associations of individual socioeconomic status with physical and cognitive functioning among Chinese elderly people, using the Latent Growth Curve Model (LGCM) and the selection model. Repeated measurements of physical and cognitive functioning facilitate examination of the inter- and intra-individual trajectory of change during the ageing process. The sample for Sub-study I consisted of 11,405 individuals aged from 65 to 94 at baseline (Elder aged 95 and over were excluded because of high proportion of attrition in the follow-up), and for Sub-study II of 15,798 65-to-105-year-olds at baseline.

Sub-study III was based on the fourth set of CLHLS data from 2005. The cross-sectional sample covered 14,336 individuals aged 65 and above, 56 per cent of them female. From 2005 onwards the survey included information on the education of offspring, which is why the 2005 sample was chosed for this Sub-study. The aim was to examine the possible effect of family members' education on the self-rated health of elderly people, adjusted for the possible covariates.

Sub-study IV utilized the three sets of data from 2005 to 2011 comprising 15,355 respondents aged 65-105. Mortality information was based on death certificates. Our aim was to investigate in a longitudinal setting the extent and nature of any association between the educational levels of co-resident family members and mortality risk among the elderly.

Analyses of sub-studies II, III and IV were all stratified by gender given the difference between elderly males and females. Table 1 summarises the basic characteristics of the four study samples and design.

Table 1. Characteristics of the study samples and design

	Sub-studies			
	I	II	III	IV
Age range (baseline)	65-94	65-105	65-120	65-105
Females (baseline, %)	58	57	56	57
Survey period	2002-2011	2002-2011	2005	2005-2011
N (baseline)	11,405	15,798	14,336	15,355
Dataset type	longitudinal repeated measures	longitudinal repeated measures	cross-sectional	longitudinal

5.2 MEASURES

5.2.1 HEALTH OUTCOMES

Physical functioning (Sub-study I) was measured on the self-reported ADL scale developed by Katz (Katz 1983) and Lawton and Brody's IADL scale (Lawton and Brody 1969). The ADL refers to personal basic activities associated with daily life and is widely used to assess the physical functioning and disability of older people. The respondents were asked whether they needed assistance in completing the following six basic tasks: bathing, dressing, going to the toilet, getting in and out of bed, maintaining continence and feeding (coded 0=need no assistance, 1=need some assistance and 2=need full assistance). The IADL items are taken from different global sources of major surveys for the elderly. The interviewers asked the respondents whether they could carry out eight activities by themselves, independently. The eight items cover visiting neighbours, shopping, cooking a meal, washing clothes, walking continuously for one kilometre at a time, lifting a weight of 5 kg, crouching and standing up continuously three times, and using public transportation (coded 0=fully independently, 1=need some help and 2=no, cannot). Prior studies have demonstrated that the validity and reliability of ADL and IADL as used with the CLHLS data are good (Gu 2008). It should be noted that proxy respondents, such as close family members, answered some of the ADL and IADL questions so as to reduce the non-response rate, especially among the oldest group. In the present sample, for example, the elderly respondents answered 75-85 per cent of the six ADL questions, depending on the phase. Proxies have been shown to produce fairly accurate factual information, and full non-response was quite low (less than 4%) for the different phases of the CLHLS data (Gu 2008). The ADL and IADL questions relate mainly to objective and factual aspects of daily life, thus the potential proxy-related bias is not substantial (Zimmer et al. 2012). The total ADL scores ranged from zero to 12, and the IADL scores from zero to 16. Given that higher scores on both scales indicate poorer physical health, continuous ADL or IADL scores was used to assess the changes and the trajectory.

Cognitive functioning (Sub-study II) was measured by the Chinese version of MMSE, based on the international Mini-Mental State Examination (MMSE) developed by Folstein et al. (Folstein et al. 1975). MMSE is one of the most widely used screening devices for assessing the cognitive mental status and cognitive impairment among older people (Gagnon et al. 1990). It comprises 11 questions covering orientation capacity, registration, attention and calculation ability, recall, and language ability (Folstein, Folstein and McHugh 1975). Several items were adapted for the Chinese version to suit the cultural context of China. It has been demonstrated in earlier studies that the validity and reliability of Chinese MMSE measurements are good (Gu 2008, Zhang et al. 2008). The respondents answered all the questions in the four phases without needing a proxy. The item was coded zero and calculated into the MMSE scores if the respondent could not answer the question. The total MMSE scores ranged from zero to 30, higher scores indicating better cognitive functioning, and again continuous MMSE scores was used to assess the changes and the trajectory. The sample used in Sub-study II included elderly people with a zero value of cognitive functioning, although the numbers were proportionately very small (less than 0.5%) and sensitivity analyses excluding these respondents produced comparable results.

Self-rated health (Sub-study III) has been found to be a good predictor of health and mortality among older adults (Jylhä 2009). The respondents were asked: “How do you rate your health at present?” and were required to answer this question without a proxy. The response alternatives were: very good, good, fair, poor, very poor and not able to answer. Self-rated health was reclassified into three categories: good (including very good and good), fair and poor (including very poor and poor). Those who did not answer were dropped out of the sample.

Mortality risk (Sub-study IV) was expressed as Hazard Ratios (HR) obtained from the Cox proportional hazards model. Mortality data were obtained from the death certificate, next of kin or neighbourhood committees, and all mortality data were validated (Bennett et al. 2013). This is explained in detail in the methods section.

5.2.2 SOCIOECONOMIC STATUS

In most previous studies socioeconomic status is measured by educational attainment, occupation and income. The main measures used in this study were educational attainment, household income and occupational status. Adequacy of financial resources and access to health services were also included in Sub-study I given that education, income and occupation would not have fully represented the socioeconomic background of elderly Chinese people. Only education and household income were used as indicators of socioeconomic status in Sub-study II. Three indicators were used in Sub-studies III and IV (education, household income and occupation) for the sake of consistency, taking the highest educational attainment as the indicator of spousal and offspring's socioeconomic status.

Education: Because nearly half of the elderly subjects had not had any formal education, it was recoded in three categories: low (no schooling, 0 years), intermediate (primary school, 1-6 years) and high (middle school or more, 7 years or more). This classification was used in all four sub-studies.

Occupational status before the age of 60: The classification differed slightly in the sub-studies. The following five categories were used in Sub-study I: farmers, white-collar workers (including professional and technical personnel, governmental, institutional or managerial staff and military personnel), employer or self-employed, housework or unemployed, and others. These were reduced to four categories in Sub-study III: non-manual if the respondent's occupation before the age of 60 was "professional and technical personnel", "governmental, institutional or manager" or "military personnel"; manual, if it was "commercial, service or industrial worker"; farmer, if it was agriculture, forestry, husbandry and fishery; and others including household workers. Three categories were used in Sub-study IV: farmers, white-collar workers (including professional and technical personnel, governmental, institutional or managerial staff and military personnel) and others.

Household income per capita (household total income divided by the number of co-resident family members) was divided into quartiles in all four sub-studies.

Spousal education: Given the collinearity, spousal education and living arrangements were recombined as follows: 1) low education (0 years), living with a spouse; 2) intermediate education (1-6 years), living with a spouse; 3) high education (7 years or more), living with a spouse; 4) no co-resident spouse.

Adult offspring's education was classified into five categories, which differed slightly from those of parental education: a low education included no education and primary school (0 years or 1-6 years); intermediate education included middle school (7-9 years); high indicated upper-secondary education or above (10 years or more); no co-resident children. In the cases of elderly people living with more than one child, educational attainment reflected the attainment of the most highly educated.

Those with missing information were included as a separate category given that the proportion of missing values was quite low (less than five per cent).

5.2.3 COVARIATES

Age and residential area (rual or urban) were adjusted for in all models in all the sub-studies. A self-reported history of cardio-metabolic disease was also adjusted for in the final model in Sub-study I to assess the possible mediate effect of such diseases on physical functioning. Marital status (0=widowed or divorced, 1=have a spouse) and living arrangements (living with family members, alone or in an institution) were included in Sub-study II. Chronic diseases such as hypertension, diabetes, heart disease, stroke or cerebrovascular disease, and bronchitis, pneumonia or asthma were coded into dummy variables and included in Sub-study III. Psychological indicators including thinking positively and feeling lonely (both categorised as always, seldom, sometimes and no response) were also controlled for in Sub-study III. Health behaviours such as drinking and smoking status, and regular physical exercise (yes or no), were adjusted for in the models in Sub-studies III and IV.

5.3 STATISTICAL METHODS

The latent growth curve model and the selection model were used to examine the longitudinal association between socioeconomic status and physical and cognitive functioning in Sub-studies I and II, and repeated measurements of physical and cognitive functioning allowed us to investigate the trajectories of change. Two latent factors - intercept (i.e. baseline status or level) and slope (i.e. rate of change) - were specified to model the trajectory of ADL, IADL and MMSE scores from phase 1 to phase 4.

The model with a higher-order growth factor and one with free time scores were tested in Sub-studies I and II, and then both linear and non-linear change trajectories were tested. Given that the non-linear model in which the last time loading of the slope factor was estimated freely (5.37 for ADL and 3.44 for IADL in Sub-study I; MMSE scores 2.2 for males and 2.7 for females in Sub-study II) provided an adequate fit for the data (model fit for non-linear models in Sub-study I: Chi-square=80.94, df=4, CFI=0.96, TLI=0.95, RMSEA=0.04 and SRMR=0.05 for ADL; Chi-square=23.51, df=4, CFI=0.99, TLI=0.99, RMSEA=0.02 and SRMR=0.02 for IADL. Chi-square difference test between linear and non-linear model: ΔChi-square=73.61, Δdf=1, $p<0.001$ for ADL; ΔChi-square=15.28, Δdf=1, $p<0.001$ for IADL; For MMSE in Sub-study II: Chi-square=3.78, p=0.43 for males and Chi-square=9.25, p=0.06 for females), this model was used in the subsequent analyses in the first two studies.

The intercept and slope factors were regressed on various indicators of socioeconomic status. Age, gender, residential area and marital status (married and unmarried) were adjusted for in Sub-study I, and age, marital status, living arrangements and residential area (rural and urban) were included in the model as covariates in Sub-study II.

Models stratified by gender and different age groups were not estimated in Sub-study I because there were no substantial differences in the patterns of change in the ADL and IADL scores between males and females or between the age groups in our preliminary analyses. In Sub-study II, multi-group analyses by males and females indicated statistically significant ($p<0.001$) gender differences in the effect of socioeconomic status on the intercept and slope of cognitive functioning, and gender-specific analyses were conducted accordingly. The Tucker-Lewis index (TLI) ⩾0.95, the Comparative Fix index (CFI) ⩾0.95, the Root Mean Square Error of Approximation (RMSEA) ⩽0.06 and the Standardised Root Mean Square Residual (SRMR) ⩽0.06 were used to determine the model fit of LGCM in Sub-study I and II, as suggested by Hu and Bentler (Hu and Bentler 1999).

Age was centred at the mean in both Sub-study I and Sub-study II. Coefficients from model 0 adjusted for age and each independent variable were first presented. In Sub-study I, estimates from the selection model were presented for all models and the estimates from model 0 to model 2 were presented, controlling for all socioeconomic status indicators (education, occupational status and household income, financial resources and access to health services) and other covariates. The sample used in the sub-study I also included the institutionalised population (956 institutionalized older adults) and therefore results from the sensitivity analyses that excluded those living in an institution were presented in model 2.

In Sub-study II the results of model 1 from the latent growth model were first presented, and estimates from the selection model were showed in the last model (2). Education and household income per capita were estimated in models 1 and 2, controlling for age, gender, living area, and other covariates.

Diggle and Kenward's selection model was applied in Sub-studies I and II. It is one of the classic missing-not-at-random (MNAR) modelling approaches to take account of data attrition (Figure 6), combining the latent growth curve model with a set of regression equations that predict missingness. The probability of missing data in each phase depends directly on the repeated measurements (Diggle and Kenward 1994). The results of the selection model could be used to confirm the LGCM results.

Multinomial logistic regression was used in Sub-study III. Odds Ratios (ORs) and their 95-per-cent confidence intervals (CIs) of models 1 and 2 were reported. In model 1, three health-behaviour variables as well as for self-reported chronic diseases were adjusted for. Psychological variables were included into the last model (2). Interaction effect between the respondent's and the offspring's education when predicting self-rated good health was also tested. The estimates for males and females were calculated separately. Weights for the descriptive statistics were used to calculate the percentages for the general population, but it was not used for the multinomial logistic regression given that the related age, gender and residential area had already been controlled for (Gu et al. 2009, Winship and Radbill 1994).

Cox proportional hazards regression model was applied to calculate socioeconomic differentials in mortality (Sub-study IV). Hazard ratios (HR) and 95% CI were calculated from the multivariate models, controlling for socio-demographic variables, self-rated health and health-behaviour factors. The estimates from models 1 and 2 are presented. HR adjusted for age and both spousal and offspring's education was first estimated. In model 2, individual socioeconomic status, demographic variables, the educational level of the spouse or adult children, self-rated health and health-behaviour variables (smoking status and physical exercise) were controlled for. All the models were run for males and females separately. In Sub-study IV the interaction effect between the education of the elderly and of their offspring in predicting mortality among the elderly was also examined.

Mplus version 7 (Muthén 2007) was used for the analyses in Sub-study I and Sub-study II, and Stata 11.2 (Stata Corp, College- Station, Texas) was used in Sub-study III and Sub-study IV. Table 2 summarises the variables and statistical methods used in the different sub-studies.

Table 2. Variables and statistical methods used in the sub-studies

	Sub-study I	Sub-study II	Sub-study III	Sub-study IV
Outcome	Physical Functioning (ADL and IADL)	Cognitive functioning (MMSE)	Self-rated health	Mortality Risk
SES	Education, Household income, Occupational status, Adequacy of financial resources, Access to health services	Education, Household income	Education, Household income, Occupational status	Education, Household income, Occupational status
Family member's socioeconomic status	--	--	Spousal education (low, intermediate, high, no spouse ,and missing) Child's education (low, intermediate, high, no spouse, and missing)	Spousal education (low, intermediate, high, no spouse ,and missing) Child's education (low, intermediate, high, no spouse, and missing)
Interactions with the main variables	--	--	Respondent's education and Children's education	Respondent's education and Children's education
Covariates	Age, Gender, Residential areas Marital status, History of cardio-metabolic diseases (diabetes, cardiovascular disease and stroke, heart disease)	Age, Residential area, Marital status, Living arrangements	Age, Residential area, Smoking, Drinking, Physical exercise, Medical Services, Chronic diseases, Thinking positively, Feeling lonely	Age, Residential area, Self-rated health, Smoking status, Exercise
Stratification	--	Gender	Gender	Gender
Statistical Methods	Latent growth-curve model and selection model	Latent growth curve-model and selection-model	Multinomial-logistic-regression	Cox multivariate-proportional-hazards regression

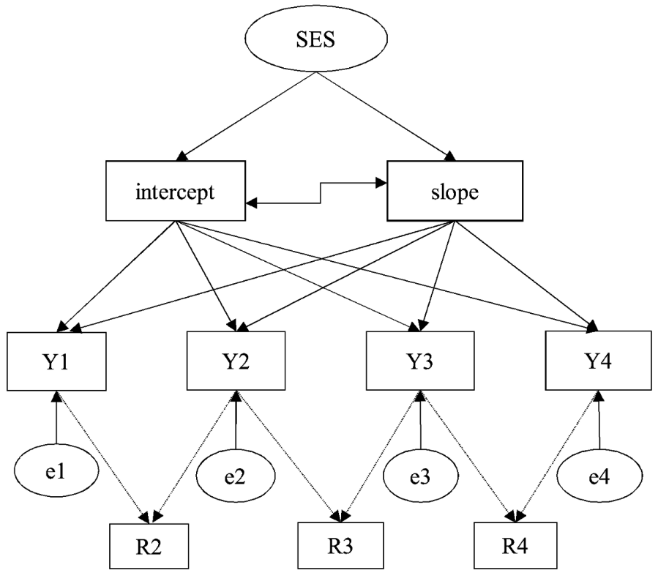

Figure 6. Path diagram of the selection model for the trajectory of physical and cognitive functioning among the Chinese elderly based on (Enders 2011): Y1-Y4 are outcome variables (ADL/IADL or MMSE); R2-R4 are missing data indicators (dummy variable indicating whether participates were observed or lost to follow-up); e1- e4 are time-specific residuals; SES = socioeconomic status.

6 RESULTS

6.1 SOCIOECONOMIC STATUS AND PHYSICAL FUNCTIONING (SUB STUDY I)

Table 3 gives the results from the selection model examining the socioeconomic trajectory of ADL functioning. Following adjustments for each variable by age and gender in model 0, employer/self-employed, housework/unemployed, inadequate financial resources, no access to health services were associated with higher ADL scores, indicating poorer physical functioning at baseline. Education, income, inadequate financial resources and no access to health services were not related to the slope of the ADL scores. When education, household income, occupational status, inadequate financial resources and no access to health services with all covariates were included in model 1, the mean intercept (baseline level of ADL) was 0.42 and the mean slope (rate of change) was 0.65, indicating that the ADL score increased by 0.65 points in every phase (3-year intervals). Neither high education nor white-collar occupation nor highest income related to the baseline ADL level or the rate of change in the ADL scores. Those with housework/unemployed as an occupational status continued to achieve higher ADL scores than farmers. Consistent with the results from previous models, neither high education nor white-collar occupation nor highest income was associated with the rate of decline in ADL (the coefficients of the slopes) in model 1. Inadequacy of financial resources predicted higher ADL scores at baseline in model 0 but this association disappeared in the model 1, and no access to health services was associated with poorer ADL functioning but not with the rate of change in two of the models. Results from model 2 excluding those living in institutions were similar with those from model 1 except that higher income quartiles were associated with slower rate of change of ADL.

Table 3. Results from the Selection model for ADL

	Model 0 (95% CI)	Model 1 (95% CI)	Model 2[a] (95% CI)
Means			
Intercept	/	0.42 (0.34,0.51)	0.42 (0.34,0.51)
Slope	/	0.65 (0.56,0.74)	0.65 (0.56,0.74)
Covariates predicting the intercept (beta coefficients)			
Education (ref.=low)			
Intermediate education	-0.07 (-0.15,0.01)	**-0.09 (-0.16,-0.02)**	**-0.10 (-0.17,-0.03)**
High education	-0.03 (-0.13,0.07)	-0.07 (-0.18,0.04)	-0.07 (-0.18,0.05)
Missing education	0.80 (0.14,1.46)	0.68 (-0.11,1.47)	0.31 (-0.60,1.22)
Household income (ref.=lowest)			
Second income quartile	-0.07 (-0.15,0.01)	-0.03 (-0.11,0.05)	-0.02 (-0.10,0.06)
Third income quartile	0.01 (-0.08,0.08)	0.01 (-0.08,0.09)	0.01 (-0.08,0.09)
Highest income quartile	0.07 (-0.02,0.16)	0.04 (-0.05,0.14)	0.04 (-0.06,0.14)
Missing income	0.13 (-0.05,0.30)	0.11 (-0.05,0.28)	-0.01 (-0.18,0.16)
Occupational status (ref.=farmers)			
Whiter collar	0.06 (-0.04,0.16)	-0.04 (-0.15,0.08)	-0.02 (-0.14,0.09)
Employer/self-employed	**0.10 (0.01,0.19)**	0.04 (-0.05,0.13)	0.03 (-0.06,0.13)
Housework/unemployed	**0.30 (0.18,0.42)**	**0.25 (0.14,0.36)**	**0.28 (0.16,0.40)**
Others	0.01 (-0.24,0.24)	-0.06 (-0.29,0.17)	-0.01 (-0.25,0.23)
Missing	0.53 (0.01,1.05)	-0.01 (-0.74,0.74)	0.16 (-0.74,0.74)
Financial resources inadequate	**0.12 (0.04,0.20)**	0.06 (-0.02,0.15)	0.07 (-0.01,0.16)
No access to health services	**0.21 (0.09,0.33)**	**0.17 (0.05,0.30)**	**0.18 (0.06,0.31)**
Covariates predicting the slope (beta coefficients)			
Education (ref.=low)			
Intermediate education	0.05 (-0.02,0.12)	0.02 (-0.05,0.08)	0.02 (-0.05,0.08)
High education	0.01 (-0.09,0.10)	-0.03 (-0.13,0.07)	-0.04 (-0.14,0.06)
Missing education	-0.27 (-0.80,0.26)	0.03 (-0.63,0.69)	0.27 (-0.46,0.99)
Household income (ref.=lowest)			
Second income quartile	-0.06 (-0.14,0.01)	-0.06 (-0.13,0.01)	**-0.08 (-0.14,-0.01)**
Third income quartile	-0.05 (-0.12,0.03)	-0.06 (-0.13,0.01)	**-0.08 (-0.15,-0.01)**
Highest income quartile	0.08 (-0.01,0.16)	0.03 (-0.06,0.12)	0.01 (-0.08,0.09)
Missing income	0.03 (-0.13,0.19)	0.06 (-0.09,0.21)	0.11 (-0.04,0.26)
Occupational status (ref.=farmers)			
Whiter collar	0.08 (-0.01,0.18)	0.02 (-0.08,0.13)	0.04 (-0.07,0.14)
Employer/self-employed	**0.16 (0.08,0.24)**	**0.10 (0.01,0.18)**	**0.09 (0.01,0.17)**
Housework/unemployed	**0.11 (0.00,0.22)**	0.09 (-0.01,0.20)	0.08 (-0.02,0.19)
Others	0.14 (-0.10,0.38)	0.15 (-0.08,0.37)	0.10 (-0.12,0.31)
Missing	-0.28 (-0.90,0.34)	-0.20 (-1.02,0.62)	-0.28 (-1.24,0.67)
Financial resources inadequate	-0.05 (-0.11,0.03)	-0.04 (-0.11,0.03)	-0.05 (-0.12,0.03)
No access to health services	0.01 (-0.09,0.11)	0.07 (-0.03,0.16)	0.05 (-0.06,0.15)

Note: a. Model 2 provides the results from the sample that excludes the institutionalized older adults. Statistically significant ($p<0.05$) beta coefficients of the main variables have been bolded. Beta coefficients for the association between history of cardio-metabolic diseases and ADL in the four waves in model 3 were 0.64, 0.94, 0.79 and 0.23, respectively (all statistically significant at $p<0.05$ level).M0=age+gender+education/income /occupation / financial resources /health services/residential area/marital status; M1= age+gender+education+income+occupation+financial resources+health services+residential area+marital status+history of cardio-metabolic diseases. M2 included all covariates.

The IADL and the ADL results differed somewhat. In table 4, Intermediate and high education and higher household income were all associated with lower IADL scores in model 0, indicating better physical functioning at baseline. The elderly whose occupational status was housework or unemployed and who reported inadequacy of financial resources or no access to health services had higher IADL scores, indicating poorer IADL functioning. Employer or self-employed was associated with higher rate of change of IADL. The mean intercept (baseline level of IADL) in model 1 was 3.45 and the mean slope (rate of change) was 1.87. Higher education, higher household income and unavailability of health services were still related to lower IADL scores at baseline. The results from model 2 were largely consistent with those from the previous model, except that the association between inadequate financial resources and the baseline level of IADL disappeared but in model 2 this association became significant again. There was no association between white-collar occupation and the baseline level of or the rate of change in physical functioning in any of the models.

With regard to the association between cardio-metabolic diseases and physical functioning, those who reported cardio-metabolic diseases in the different phases had higher ADL and IADL scores than those who did not have these diseases (footnotes in Table 3 and Table 4).

Table 4. Results from the Selection model for IADL

	Model 0 (95% CI)	Model 1 (95% CI)	Model 2[a] (95% CI)
Means			
Intercept	/	3.45 (3.22,3.69)	3.39 (3.15,3.63)
Slope	/	1.87 (1.67,2.06)	1.85 (1.64,2.05)
Covariates predicting the intercept (beta coefficients)			
Education (ref.=low)			
Intermediate education	**-0.38 (-0.57,-0.19)**	**-0.35 (-0.54,-0.16)**	**-0.32 (-0.52,-0.12)**
High education	**-0.38 (-0.65,-0.10)**	**-0.32 (-0.63,-0.01)**	-0.30 (-0.62,0.01)
Missing education	1.92 (0.42,3.42)	1.68 (-0.10,3.45)	1.27 (-0.80,3.00)
Household income (ref.=lowest)			
Second income quartile	**-0.54 (-0.77,-0.31)**	**-0.40 (-0.63,-0.18)**	**-0.36 (-0.59,-0.13)**
Third income quartile	**-0.38 (-0.61,-0.15)**	**-0.29 (-0.52,-0.06)**	**-0.24 (-0.48,-0.01)**
Highest income quartile	**-0.48 (-0.72,-0.24)**	**-0.43 (-0.69,-0.17)**	**-0.41 (-0.67,-0.14)**
Missing income	0.57 (0.13,1.01)	0.58 (0.15,1.01)	0.57 (0.11,1.02)
Occupational status (ref.=farmers)			
Whiter collar	-0.11 (-0.38,0.16)	-0.02 (-0.34,0.30)	0.01 (-0.32,0.34)
Employer/self-employed	0.07 (-0.17,0.30)	0.10 (-0.14,0.35)	0.08 (-0.17,0.33)
Housework/unemployed	**0.87 (0.57,1.17)**	**0.83 (0.54,1.13)**	**0.89 (0.58,1.19)**
Others	0.09 (-0.56,0.74)	0.10 (-0.54,0.74)	0.14 (-0.52,0.80)
Missing	1.71 (0.28,3.15)	0.23 (-1.40,1.86)	0.38 (-1.41,2.17)
Financial resources inadequate	**0.58 (0.37,0.79)**	0.20 (-0.02,0.43)	**0.24 (0.01,0.47)**
No access to health services	**1.15 (0.85,1.44)**	**0.89 (0.58,1.19)**	**0.91 (0.60,1.23)**
Covariates predicting the slope (beta coefficients)			
Education (ref.=low)			
Intermediate education	-0.01 (-0.15,0.12)	-0.03 (-0.16,0.11)	-0.06 (-0.20,0.08)
High education	-0.11 (-0.30,0.08)	-0.14 (-0.36,0.08)	-0.18 (-0.41,0.04)
Missing education	-0.83 (-1.67,0.01)	-1.12 (-2.16,-0.08)	-1.03 (-2.67,0.22)
Household income (ref.=lowest)			
Second income quartile	0.01 (-0.14,0.16)	-0.01 (-0.16,0.15)	-0.06 (-0.22,0.09)
Third income quartile	0.03 (-0.12,0.19)	-0.01 (-0.18,0.15)	-0.05 (-0.21,0.12)
Highest income quartile	0.11 (-0.07,0.28)	0.04 (-0.15,0.23)	0.01 (-0.18,0.21)
Missing income	-0.05 (-0.37,0.27)	-0.01 (-0.33,0.31)	-0.05 (-0.41,0.32)
Occupational status (ref.=farmers)			
Whiter collar	0.03 (-0.16,0.22)	-0.04 (-0.27,0.19)	-0.03 (-0.27,0.21)
Employer/self-employed	**0.19 (0.02,0.36)**	0.13 (-0.06,0.31)	0.13 (-0.06,0.31)
Housework/unemployed	-0.03 (-0.24,0.17)	-0.05 (-0.27,0.16)	-0.10 (-0.32,0.11)
Others	0.26 (-0.20,0.71)	0.28 (-0.16,0.72)	0.29 (-0.16,0.74)
Missing	-0.14 (-1.11,0.83)	0.45 (-0.72,1.63)	0.83 (-0.45,2.11)
Financial resources inadequate	**-0.15 (-0.29,-0.01)**	-0.08 (-0.24,0.07)	-0.10 (-0.26,0.06)
No access to health services	**-0.40 (-0.60,-0.19)**	**-0.33 (-0.55,-0.10)**	**-0.34 (-0.56,-0.11)**

Note: a. Model 2 provides the results from the sample that excludes the institutionalized older adults. Statistically significant ($p<0.05$) beta coefficients of the main variables have been bolded. Beta coefficients for the association between history of cardio-metabolic diseases and ADL in the four waves in model 3 were 1.81, 1.96, 1.54 and 2.03, respectively (all statistically significant at $p<0.05$ level).

M0=age+ gender + education/ income /occupation / financial resources /health services/residential area/marital status;

M1= age +gender + education + income + occupation + financial resources+ health services+ residential area +marital status + history of cardio-metabolic diseases.

M2 included all covariates.

6.2 SOCIOECONOMIC STATUS AND COGNITIVE FUNCTIONING (SUB-STUDY II)

Cognitive functioning measured in terms of MMSE scores declined with age: the scores declined between the first and the last phases among both males and females (Figure 7). Elderly males had higher scores than their female counterparts in the different age groups, indicating that men had better cognitive functioning than women.

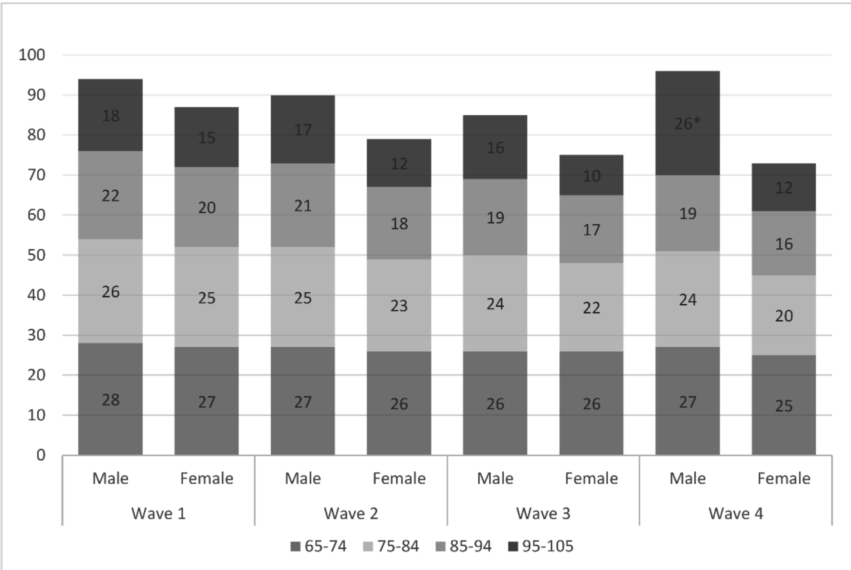

Figure 7. Distributions of MMSE scores by gender and age group (at baseline) cohort. * Only have 8 observations.

Table 5 and 6 present the estimates from the latent growth model (Model 1) and the selection model (Model 2) for males and females. Among the males (Table 5), the mean intercept (baseline level of MMSE) in model 1, including all the variables, was 21.02 and the mean slope (the rate of change) was -1.46, indicating that cognitive functioning declined by 1.46 in every phase. Education and higher household income were associated with the intercept of the MMSE scores, indicating that a higher educational level and household income were statistically significantly positive factors for cognitive functioning at baseline: For example, elderly people with an intermediate or high education achieved higher MMSE scores (1.71 and 2.45, respectively) than those with a low education. With regard to change in cognitive functioning, in other words the slope, education had no significant effect on the rate of decline in MMSE scores. The implication is that the association between education and cognitive functioning remained at the same level over aging and that those with higher cognitive functioning maintained this advantage during the follow-up.

When selective dropout was taken into account in model 2 the absolute value of the mean slope became larger. The effects of the education and household-income quartiles on the MMSE scores attenuated slightly relative to each other. However, the results were quite similar to those from model 1: a higher educational level and higher household income were still associated with better cognitive performance at baseline. Education was not associated with the rate of cognitive decline. However, the negative and significant associations of the second, third and highest income quartiles with the slope indicated that the elderly people in these income quartiles had higher rates of cognitive decline than those in the lowest quartile, leading to narrower age-related income differences in cognitive functioning.

The results for the females and the males were quite similar. Higher levels of education and household income constituted a positive predictor of cognitive functioning at baseline, but only high household income was associated with the age-related rate of change in MMSE scores.

Table 5. The Results from the Latent Growth Model and the Selection Model for cognitive functioning among males

	Model 1 (95% CI)	Model 2 (95% CI)
Means		
Intercept	21.02 (20.59, 21.46)	20.98 (20.49, 21.47)
Slope	-1.46 (-1.86, -1.06)	-3.53 (-4.00, -3.06)
Covariates predicting the intercept (beta coefficients)		
Intermediate education[a]	**1.71 (1.35, 2.07)**	**1.73 (1.34, 2.12)**
High education[b]	**2.45 (1.96, 2.95)**	**2.43 (1.95, 2.91)**
Second income quartile[c]	**1.06 (0.59, 1.53)**	**1.07 (0.58, 1.57)**
Third income quartile[d]	**1.38 (0.93, 1.84)**	**1.38 (0.92, 1.8)**
Highest income quartile[e]	**1.42 (0.94, 1.90)**	**1.44 (0.94, 1.94)**
Covariates predicting the slope (beta coefficients)		
Intermediate education[a]	-0.26 (-0.57, 0.06)	-0.34 (-0.68, 0.01)
High education[b]	0.02 (-0.40, 0.44)	-0.15 (-0.59, 0.28)
Second income quartile[c]	-0.27 (-0.65, 0.11)	-0.24 (-0.63, 0.14)
Third income quartile[d]	-0.22 (-0.60, 0.16)	**-0.46 (-0.86, -0.06)**
Highest income quartile[e]	-0.36 (-0.79, 0.06)	**-0.78 (-1.24, -0.32)**
Variances		
Intercept	22.63 (18.40, 26.87)	26.11 (20.09, 32.13)
Slope	2.33 (0.40, 4.26)	5.46 (2.72, 8.21)
Correlation (standardized)		
Slope with intercept	-0.33 (-0.60, -0.05)	-0.44 (-0.62, -0.26)

Note: Statistically significant ($p<0.05$) beta coefficients of the main variables are in bold.

Model 1 is adjusted for age, marital status, living arrangements and residential area.

Model 2 is a selection model adjusted for age, marital status, living arrangements and residential area.

Reference groups: a,b. no education. c,d,e. lowest income quartile.

Table 6. The Results from the Latent Growth Model and the Selection Model for cognitive functioning among females

	Model 1 (95% CI)	Model 2 (95% CI)
Means		
Intercept	20.09 (19.75, 20.43)	20.07 (19.72, 20.41)
Slope	-1.64 (-1.92, -1.36)	-3.50 (-3.85, -3.16)
Covariates predicting the intercept (beta coefficients)		
Intermediate education[a]	**1.01 (0.56, 1.46)**	**1.01 (0.60, 1.42)**
High education[b]	**2.58 (1.74, 3.42)**	**2.65 (1.92, 3.37)**
Second income quartile[c]	**1.70 (1.27, 2.12)**	**1.68 (1.25, 2.12)**
Third income quartile[d]	**2.10 (1.68, 2.53)**	**2.05 (1.62, 2.48)**
Highest income quartile[e]	**1.67 (1.21, 2.14)**	**1.63 (1.16, 2.11)**
Covariates predicting the slope (beta coefficients)		
Intermediate education[a]	0.33 (-0.01, 0.67)	0.13 (-0.22, 0.47)
High education[b]	0.48 (-0.18, 1.14)	-0.02 (-0.68, 0.65)
Second income quartile[c]	**-0.53 (-0.87, -0.21)**	**-0.62 (-0.98, -0.26)**
Third income quartile[d]	**-0.41 (-0.75, -0.07)**	**-0.61 (-0.98, -0.23)**
Highest income quartile[e]	-0.21 (-0.60, 0.17)	**-0.63 (-1.06, -0.20)**
Variances		
Intercept	22.06 (18.29, 25.82)	24.32 (19.53, 29.10)
Slope	1.28 (-0.20, 2.77)	3.11 (0.92, 5.30)
Correlation (standardized)		
Slope with intercept	-0.29 (-0.57, -0.01)	-0.26 (-0.51, 0.00)

Note: Statistically significant (p<0.05) beta coefficients of the main variables are in bold.

Model 1 is adjusted for age, marital status, living arrangements and residential area.

Model 2 is a selection model adjusted for age, marital status, living arrangements and residential area.

Reference groups: a,b. no education. c,d,e. lowest income quartile.

6.3 SPOUSAL AND CHILDREN'S EDUCATION AND HEALTH (SUB-STUDIES III AND IV)

Among both males and females, individual household income was associated with good self-rated health in models 1 and 2 (Figures 8 and 9). For example, those in the third income quartile had a nearly 50-per-cent higher likelihood of reporting good health. However, elderly people co-residenting with a more highly educated spouse was not significantly associated with self-rated good health.

Male and female elderly people living with highly educated children were more likely to report good health. Including individual-level socioeconomic status, health-related behaviours (drinking, smoking, medical care and exercise) and psychological indicators did not attenuate these effects, indicating that offspring's education is a robust predictor of good health among the elderly (Model 2). For example, The chance of reporting good health among elderly males living with more-highly-educated children was 40-per-cent higher than among those living with less-highly-educated children (OR=1.41 , 95% CI, 1.00 to 1.98), and the OR for females being 1.38 (95% CI, 1.04 to 1.38).

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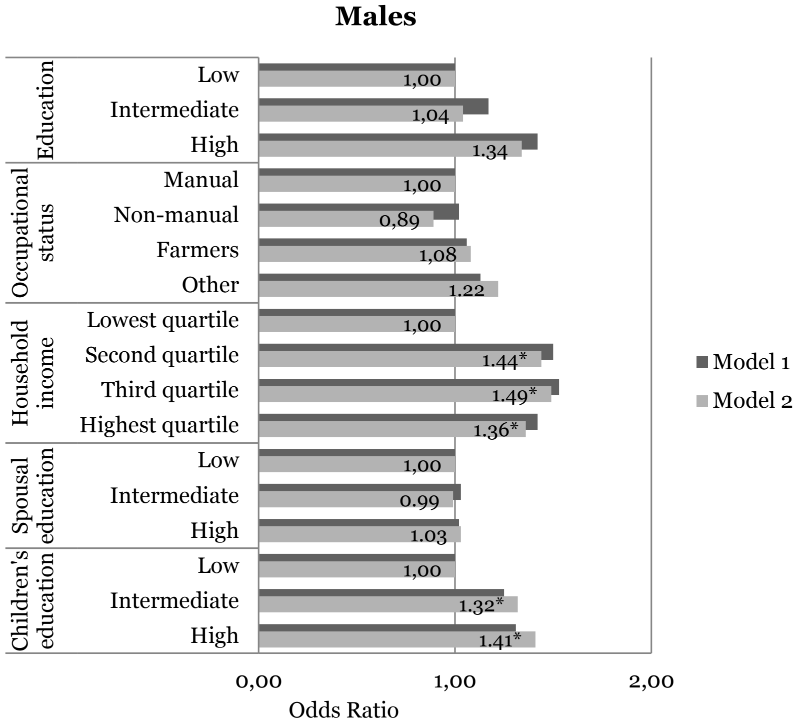

Figure 8. The Odds Ratios (ORs) of individual-level socioeconomic status, and spousal and children's education in predicting good self-rated health among males. Model 1 adjusted for residential area, health-related behaviours and chronic diseases. Model 2 adjusted for residential area, health-related behaviours, chronic diseases and psychological indicators. *Statistically significant difference at the .05 level.

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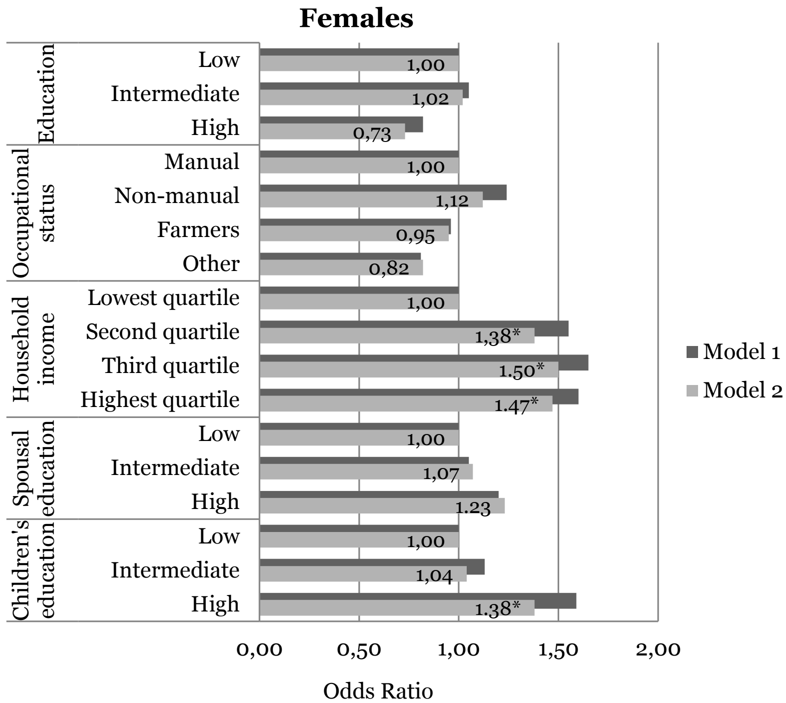

Figure 9. The Odds Ratios (ORs) of individual-level socioeconomic status, spousal and children's education in predicting good self-rated health among females. Model 1 adjusted for residential area, health-related behaviours and chronic diseases. Model 2 adjusted for residential area, health-related behaviours, chronic diseases and psychological indicators. *Statistically significant difference at the .05 level.

As Figure 10 and Figure 11 show, spousal education was associated with mortality risk among males but not females. The mortality risk among elderly males living with a more-highly-educated wife was almost 20-per-cent lower than among those living with a less-well-educated partner. In addition, a higher educational level among children was related to an almost 15-per-cent lower mortality risk among both males and females.

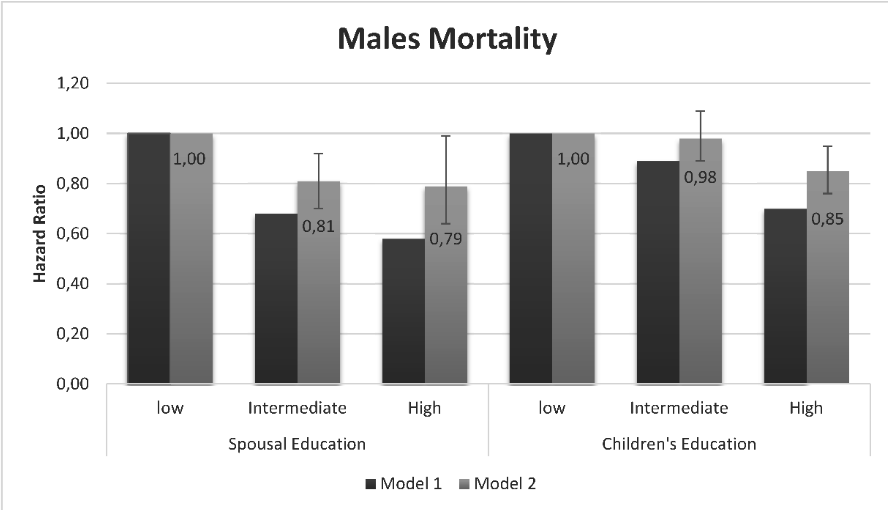

Figure 10. Hazard ratios and 95% confidence intervals from the Cox proportional model, males

Model 1 adjusted for age and each socioeconomic status.

Model 2= age+individual-level socioeconomic status +self-rated health and health-related behaviours.

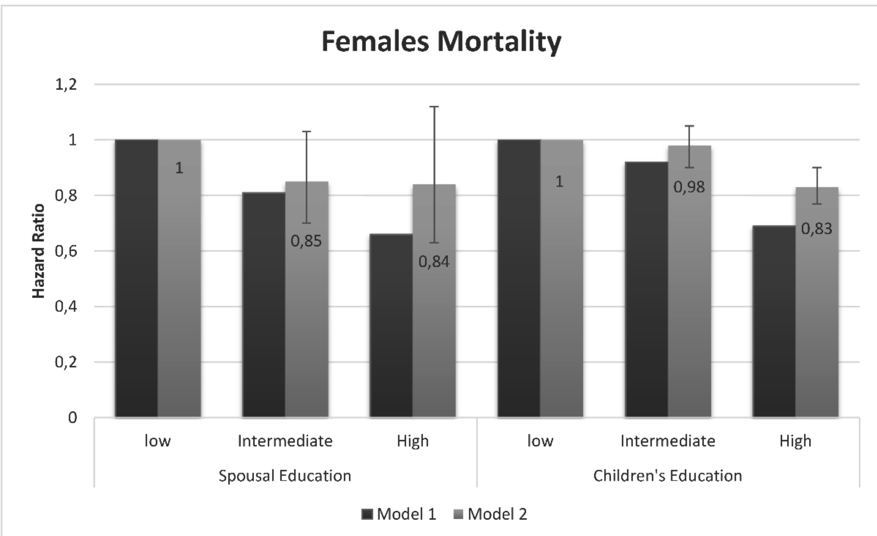

Figure 11. Hazard ratios and 95% confidence intervals from the Cox proportional model, females

Model 1 adjusted for age and each socioeconomic status.

Model 2= age+individual-level socioeconomic status +self-rated health and health-related behaviours.

The interaction effect for self-rated health was statistically significant only for females (p=0.03, see Table 8). As Table 8 shows, elderly females with a low educational level were more likely to report good health if they lived with a highly-educated child: among the low-educated group, for example, those living with a highly-educated child had were 1.62 (95% CI: 1.23-2.13) times more likely to report good health. A significant effect was not found among females with a high level of education residing with a highly educated child (OR=1.73, 95% CI: 0.86-3.47).

Table 7. Interaction effects between parents' and children's education for predicting good self-rated health (OR, 95%CI), males.

Children's education / Parents' education	Low	Intermediate	High
Low	1.00	1.34 (0.91,1.95)	2.22 (1.22,4.02)
Intermediate	1.14 (0.81,1.59)	1.50 (1.06,2.12)	1.70 (1.10,2.60)
High	1.76 (0.90,3.42)	2.35 (1.30,4.26)	1.48 (0.92,2.39)
Statistical significance: p=0.38			

Table 8. Interaction effects between parents' and children's education for predicting good self-rated health (OR, 95%CI), females.

Children's education / Parents' education	Low	Intermediate	High
Low	1.00	1.15 (0.94,1.40)	**1.62 (1.23,2.13)**
Intermediate	0.78 (0.53,1.13)	1.34 (0.89,1.99)	1.55 (0.99,2.41)
High	0.68 (0.23,2.05)	0.79 (0.38,1.66)	1.73 (0.86,3.47)
Statistical significance: **p=0.03**			

Table 9. Interaction effects between parents' and children's education in predicting mortality risk (HR, 95%CI), males

Children's education / Parents' education	Low	Intermediate	High
Low	1.00	1.08(0.93, 1.25)	**0.69 (0.57, 0.82)**
Intermediate	0.88 (0.77-1.02)	**0.76 (0.66-0.88)**	**0.65 (0.56-0.76)**
High	1.13 (0.89-1.44)	**0.62 (0.48-0.80)**	**0.70 (0.57-0.85)**
Statistical significance: **p=0.002**			

Table 10. Interaction effects between parents' and children's education in predicting mortality risk (HR, 95%CI), females

Children's education / Parents' education	Low	Intermediate	High
Low	1.00	0.92 (0.85-1.00)	0.70 (0.64-0.77)
Intermediate	0.92 (0.76-1.10)	0.83 (0.69-1.00)	0.65 (0.54-0.79)
High	1.08 (0.61-1.91)	0.81 (0.50-1.32)	0.62 (0.45-0.85)
Statistical significance: p=0.15			

Unlike the interaction effect of self-rated health, that of mortality risk was statistically significant only for males (p=0.002: see Table 9): those with a low educational level had a 31-per-cent-lower mortality risk if their co-resident children had a high level of education. Highly educated elderly parents had a 30-per-cent lower mortality risk if they lived with a more highly educated child, whereas highly educated males had a 13-per-cent higher mortality risk, if their children had a low level of education.

7 DISCUSSION

7.1 A SUMMARY OF THE MAIN RESULTS

Data from the CLHLS longitudinal population-based survey was used to investigate the health and the trajectories of physical and cognitive functioning among elderly people from different socioeconomic backgrounds in China. The overall objective was to examine the associations between the socioeconomic status of individuals, the educational level of family members and the health of the elderly in the Chinese context. The study contributes to the literature in reporting up-dated research on how a varying socioeconomic status among individuals and family members affects multifactorial health indicators, and on the extent to which socioeconomic status predicts the rate of age-related change in physical and cognitive functioning.

The results indicate that individual socioeconomic status has varying effects on physical and cognitive functioning among the elderly. With regard to physical functioning, the effect on the ADL scores was generally limited. Specifically, a high educational level was not associated with the baseline-level or the rate of change in ADL scores, but it did predict better IADL functioning at baseline. A higher income level was related to better IADL functioning but had no effect on the rate of change in either ADL or IADL in general older populations. Inadequate financial resources and no access to health services were mainly associated with poorer ADL and IADL functioning at baseline. A white-collar occupation was unrelated to the baseline level and the rate of change in physical functioning. Education and household income were all associated with cognitive functioning, on the other hand, and a higher socioeconomic status predicted better functioning at baseline. However, education was not related to the rate of change in cognitive functioning at follow-up, and higher household income lost its protective age-related effect at baseline among both males and females: in other words, those with higher household incomes lost this advantage as they aged.

There were clear associations of both spousal and offspring's education with mortality risk among elderly people: living with a spouse was associated with self-rated good health and a lower mortality risk than not having a spouse, and living with a more-highly-educated spouse posed less of a mortality risk than living with a spouse with basic education. However, there was no association between spousal education and self-rated good health among elderly males or females. Having highly educated offspring was a significant predictor of good self-rated health among elderly males and females, and was associated with a lower mortality risk among males in particular. Interaction effects were also observed between parental and children's education on predicting self-rated good health and mortality risk: elderly people with a lower educational level living with highly educated adult children were more likely to report good health and had a lower mortality risk, although the interaction effect was significant only for females. These results are discussed in more detail below.

7.2 SOCIOECONOMIC STATUS AND THE HEALTH TRAJECTORY

Socioeconomic status appears to have different effects on the trajectories of physical and cognitive functioning. Education was associated with higher levels of physical (IADL) and cognitive functioning, but not with the slope of the change in either physical or cognitive functioning. A higher household income was associated with better IADL and cognitive functioning at baseline, but not with the rate of change in physical functioning with age. A white-collar occupation was not associated with the level of or rate of change in physical functioning. Elderly people with inadequate financial resources and no access to health services mainly tended to have poorer physical functioning.

Education was not clearly associated with the baseline level or the rate of change in ADL scores, which accords with previous findings reported by Kelley-Moore et al. and Xu et al. on cohorts of elderly people aged 65+ in the USA (Kelley-Moore and Ferraro 2004, Xu et al. 2015). However, it should be noted that ADL and IADL were combined in these two studies, thus it is difficult to disentangle the true effect of education on ADL. Our results deviated from those reported in a study from the USA indicating that higher education predicted better physical functioning at baseline, and a slower rate of change in ADL (Taylor and Lynch 2004). An earlier study based on the same CLHLS data (from 1998 to 2002) and focusing on the oldest Chinese age group also reported that education and financial resources did not reduce the risk of disability (Gu and Zeng 2004). The lack of an association between education and physical functioning in our study may be attributable to the fact that the cohorts in our research sample (mostly born between 1907 and 1937) had witnessed huge turmoil and social transition in China (e.g. World War II, and the three-year Great Famine in the early 1960s in China), and these big life events might have limited the mechanisms through which high education predicts better health (Martin et al. 2014). This finding also confirmed previous evidence that education could delay the onset of functional decline, but has no effect once the process is advanced (Melzer et al. 2001). Household income was not associated with the ADL scores at baseline either, which is quite different from the IADL result and implies an association between a higher income and lower IADL scores. However, in the model excluding those living in institutions showed somewhat increased income differences in physical functioning (Higher income was associated with slower rate of change of ADL). These results suggest that material resources may be more important for those non- institutionalized older adults. In addition, slight differences in results between the dataset including and excluding the institutionalized older adults indicate that living in an institution may suffocate socioeconomic disparities in physical functioning to some extent.

The IADL and the ADL results differed: higher levels of education and household income were both associated with better IADL functioning at baseline, but not with the rate of age-related change. It has been found that elderly people with a higher income or a better financial situation have a lower IADL-disability incidence (Beydoun and Popkin 2005, Rautio et al. 2001). Moreover, IADL is generally more sensitive than ADL to improved accessibility to contextual and environmental factors such as wheeled walkers, microwave ovens and other instrumental assistance (Parker and Thorslund 2007). Thus, a higher household income may provide extra economic resources and instrumental assistance that help the elderly to maintain their physical functioning. In addition, the more-highly-educated elderly people had lower IADL scores than their less-highly-educated counterparts, indicating better physical functioning at baseline. It has been suggested that some IADL tasks may require some degree of knowledge or cognitive ability, hence the robust association between a higher education and the ability to carry out these tasks (Keddie et al. 2005). This is consistent with the finding from Sub-study II implying better cognitive functioning among more-highly-educated elderly people. Engaging in housework or being unemployed - but not doing white-collar work - was associated with higher IADL scores, indicating poorer physical functioning at baseline compared with farmers and generally consistent with the ADL results. Thus considering the results of white collars, farmers seem to have better physical functioning than other elderly people. Two possible mechanisms could explain this. The first is that argricultural labour and activities increase bodily fitness for farmers. The second is that the possible selection of those with impaired physical functioning into physically lighter occupation such as vendors which is classified as employer/self-employed in this study. Having no access to health services predicted poorer physical functioning (IADL), but was associated with a slightly lower rate of age-related decline. One explanation for this could be that those with no access to health services at baseline had poorer physical functioning, but healthcare improved a lot during the follow-up, leading to a narrower health gap from their counterparts. Overall, however, access to health services was associated with lower ADL and IADL scores at baseline, indicating that such services play an important role in maintaining physical functioning among elderly people. Account should be taken of the differences between ADL and IADL when these results are interpreted. ADL evaluates the capacity to maintain physical independence whereas IADL captures a range of more complex activities and disabilities representing less severe dysfunction (Spector et al. 1987).

Socioeconomic status was also associated with cognitive functioning at baseline but had a limited effect on the rate of age-related change. These findings are consistent with those reported in previous studies indicating that education has a strong effect on cognitive functioning during the ageing process, and that a higher education predicts better cognitive performance (Christensen et al. 2001, Karlamangla et al. 2009, Wilson et al. 2009). However, evidence was not found during the follow-up to suggest that educational differences in cognitive functioning would diminish. It may be that a higher education has a positive effect on the brain structure and thus on neural networks (Valenzuela et al. 2008): it has been found in earlier studies that people with a low level of education also have lower levels of cognitive functioning and a higher risk of dementia and Alzheimer's disease (De Ronchi et al. 1998, Evans et al. 1997). High education also helps to enhance cultural competence and cognitive-related abilities (Alley, Suthers and Crimmins 2007), factors that increase the efficiency of cognitive networks among the elderly. Our results are in line with the cognitive-reserve hypothesis according to which early-life education and engaging in stimulating activities have long-lasting effects on cerebral and cognitive development, resulting in better cognitive maintenance later in life (Amieva et al. 2014, Foubert-Samier et al. 2012). However, whether having a better education could be a consequence of having greater reserves to begin with, or whether education in itself could generate additional reserve capacity against the clinical manifestation of dementia, remain open questions (Ngandu et al. 2007).

Higher household income was associated with better cognitive functioning at baseline, but this advantage diminished during the follow-up years. Both male and female elderly people in the third and highest household-income quartiles had a stronger rate of cognitive decline during the ageing process than those in the lowest quartile. This differs substantially from the finding on physical functioning, the implication being that income is not significantly associated with ADL or IADL in general elderly population. Fewer prior studies has investiaged the association between income and cognitive functioning in particular the decline of cognitive functioning with age, and the results have not been entirely consistent. Several research has found that higher income or household income predicted better cognitive functioning (Karlamangla et al. 2009, Lee et al. 2006), while not for others (Evans et al. 1993, Lee et al. 2003). In our study, although household income was associated with rate of change in cognitive functioining, it is noteworthy that household income is highly correlated with living arrangements and it may change in the follow-up study. Thus, future study that regarding the relation between direct measurement (e.g. net worth) of income of elderly people and cognitive functioning is needed.

Evidence that high education offers protection against the rate of change in cognitive functioning was not found in the study, which is consistent with the results of previous studies conducted in the UK, The Netherlands and Canada (Muniz-Terrera et al. 2009, Van Dijk et al. 2008, Zahodne et al. 2011), but not in line with other studies indicating a lower rate of decline in cognitive functioning among more-highly-educated elderly people (Anstey and Christensen 2000, Valenzuela and Sachdev 2006). It is suggested in a previous review that indications of an association between a higher education and a lower rate of change in cognitive functioning could be attributable to attrition-related bias such as drop out (Glymour et al. 2005). In the present study, the selection model and the growth-curve model were used in combination to counter the problem of attrition in longitudinal research, and the results were generally consistent.

The finding that high education did not predict a lower rate of decline in cognitive functioning does not necessarily contradict the relatively firmly established evidence that a high socioeconomic status helps to prevent or delay the onset of dementia (Evans et al. 1997, Stern et al. 1994). Previous studies indicate that socioeconomic status could delay dementia thorough the presence of active cognitive reserves (Geerlings et al. 1997). According to our results, those with a lower educational status had lower initial levels of cognitive performance than their counterparts with a higher status. This means that their cognitive functioning declined at the same rate, so that the less-highly educated are more likely to suffer from cognitive difficulties and dementia at an earlier age, as also suggested in previous studies (Liao et al. 2005, Stern et al. 1994).

Overall, socioeconomic indicators seemed to have little effect on the rate of change in both physical and cognitive functioning in general older populations in the present study. This finding adds to current knowledge on the trajectory of health inequality in middle-income society, although the evidence in Western societies is far from conclusive. Evidence of either diverging (cumulative-disadvantage hypothesis) or converging (age-as-leveller hypothesis) socioeconomic differentials in physical functioning among the elderly in later life was not found in the present study. Inconsistent patterns of association between both physical and cognitive functioning and socioeconomic status could also reflect country-specific disparities in the stage of epidemiological transition (Myers et al. 2003). Different health-transition stages may involve different sets of risk factors regarding the health of elderly people, and our findings could reflect the mixed effects of socioeconomic status at different epidemiological stages in different countries. In Western societies, for example, cardio-metabolic diseases such as Type 2 diabetes are more prevalent among those with a lower socioeconomic status (Connolly et al. 2000, Tang et al. 2003), whereas some studies on China report that people with a higher socioeconomic status are more likely to have metabolic syndrome partly because of their earlier adoption of a high-fat diet (Xu et al. 2006, Zuo et al. 2009). Previous studies indicate that chronic ailments such as cardiovascular diseases, diabetes, arthritis and stroke make a major contribution to functional disability (Melzer et al. 2001). It has also been suggested that cardio-metabolic diseases could mediate the association between socioeconomic status and physical functioning, given that some of these diseases had direct adverse effects on physical-functioning outcomes (Boult et al. 1994, Enroth et al. 2016). In Sub-study I we adjusted for a history of cardio-metabolic disease in each phase. Although some of the socioeconomic-status indicators (e.g., being in the highest income quartile and having adequate financial resources for ADL from model 2 to model 3, and being an employer/self-employed for IADL from model 2 to model 3, see original sub-study I) lost their significant association with physical functioning, the results were generally very similar to those from previous models that did not adjust for a history of cardio-metabolic disease.

Previous studies have also shown that people with a higher socioeconomic status tend to perform better in terms of health behaviours and lifestyle, and that some behaviours such as drinking and smoking affect the progress of dementia (Anttila et al. 2004, Tyas et al. 2003). Thus the association between education and cognitive functioning may be confounded or mediated by these risk factors. However, health behaviours were adjusted for in the models in Sub-study II and the results did not change substantially, the implication being that the effect of education is largely independent of these risk factors in the case of poorer cognitive functioning. It thus seems that the varying social patterning of metabolic diseases, health behaviours and lifestyle in the Chinese context does not explain the majority of our findings.

Moreover, being context-based, both ADL and IADL usually combine physical limitations and living-environment barriers. There may well have been big improvements in the living environment and the availability of basic facilities in China, especially for those in the lower social classes, during the almost-10-year study period (Feng 2003, Tao 2015), which in turn could explain the lack of association between a higher socioeconomic status and a lower rate of age-related decline in physical functioning.

Furthermore, the nature of physical and cognitive functioning may also partly explain the limited effects of specific dimensions of socioeconomic status on the rate of age-related decline with age. Given that decline in functioning tends to be progressive, people with severe limitations in functional or cognitive performance, such as dementia sufferers, are limited in their chances of recovery. Previous studies have demonstrated that although education has an effect on the incidence of disability, it does not significantly enhance recovery (Keddie, Peek and Markides 2005, Lee and Chuang 2003, Liu et al. 1995, Zimmer et al. 1998).

7.3 FAMILY MEMBER’S EDUCATION AS A FAMILY-LEVEL RESOURCES

The extent to which their own socioeconomic status and the educational level of family members predicted self-rated good health and mortality among the Chinese elderly was examined. The contribution to the literature lie in conceptualising socioeconomic status as a family-level resource, and demonstrating the effect of co-resident spousal and offspring’s education on self-rated health and mortality in China, a middle-income country.

Elderly people living with a spouse had better self-rated health and a lower mortality risk than those living without a spouse. Moreover, living with a more-highly-educated spouse carried a lower mortality risk than living with a spouse with basic education. For example, males living with a more-highly-educated as opposed to a less-highly-educated spouse had a 21-per-cent lower mortality risk. These results indicate the importance of marriage and spouses to the health of the elderly in China. The conclusions are consistent with those reported in previous studies from England, Sweden and Norway suggesting that spousal education is a strong predictor of the partner's mortality (Bartley et al. 2004, Egeland et al. 2002, Jaffe et al. 2005, Torssander and Erikson 2009).

It has also been found in previous studies that marriage has a protective effect on health (Goldman et al. 1995, Verbrugge 1979). Among the mechanisms linking socioeconomic status and health, it supplies a social network through which couples can exchange economic and material resources as well as emotional support (Monden et al. 2003, Skalická and Kunst 2008). Having a partner with a higher education opens up access to family-level economic resources. Having a wife with a better education lowered the mortality risk among their spouses more significantly ($p<0.05$) than vice versa. A possible explanation for this interesting result is that women tend to have better health behaviours and lifestyles, which may influence spousal health behaviours such as smoking and taking physical exercise and thus benefit the husband's health (Skalická and Kunst 2008, Torssander and Erikson 2009). However, further research is warranted to assess how a wife's health behaviours and lifestyle affect her husband's health behaviours and health in the Chinese context.

No association between spousal education and self-rated good health among the elderly males or females was found. This may be because a cross-sectional dataset was used in Sub-study III in which more than half of the respondents had had no formal education, hence the difference between different levels of education was not so significant. To compensate for this limitation, the effect of spousal education on mortality risk was examined in Sub-study IV using a large longitudinal data set. A higher level of spousal education turned out to be associated with a lower mortality risk among the elderly, particularly the males.

Children's education also turned out to be a significant predictor of self-rated good health among both males and females, and was associated with a lower mortality risk among elderly males in particular. These associations imply an additional protective effect of children's higher education in terms of reducing their parents' mortality risk. These results are consistent with those reported in previous studies conducted in industrialised societies in which parents do not commonly live with their offspring (Friedman and Mare 2014, Torssander 2013, Zimmer et al. 2007). Co-residence of elderly parents with their children is quite prevalent in China, driven by a culture of filial piety as well as by the poor socioeconomic conditions of the elderly, especially those living in rural areas. Two mechanisms could explain the effect of children's education on their parents' health. First, the higher levels of economic resources and healthcare available to more-highly-educated children directly benefit the health of the elderly. The second mechanism is the intergenerational emotional support and health-information exchange. It has been found that mutual emotional support between children and parents helps to improve mental health, and reduces psychological distress and feelings of loneliness (Davey and Eggebeen 1998, Silverstein and Bengtson 1994, Zunzunegui, Beland and Otero 2001). According to our data, for example, the OR of reporting good health increased from 1.36 to 1.44 among elderly males living with more-highly-educated children following adjustment for the psychological variables. More-highly-educated children are also more likely to have access to advanced medical technology and health information, which may change the health behaviours and lifestyles of their elderly parents. Education is thus a household-level rather than a purely individual-level resource (Zimmer et al. 2007).

Our findings are consistent with those reported in studies conducted in welfare states such as the Nordic countries in which social welfare and health services are strongly supported by the government and adult children rarely co-reside with their parents (Torssander 2013, Torssander 2014). A similar association was found in China, where socioeconomic disparity is increasing and public services for the elderly are moderate. In our study, elderly males and females living with more-highly-educated children had a roughly 15-per-cent-lower mortality risk than their less-highly-educated counterparts. According to a study conducted in Sweden (Torssander 2014), elderly parents living with children educated to the tertiary level showed a similarly lower mortality risk. Social policy is comparatively egalitarian in welfare societies, socioeconomic inequality is lower, and upward intergenerational exchange and support remain strong (Fors and Lennartsson 2008). Nevertheless, adult children's education still plays an important role in the health of their elderly parents. It seems that co-residence with parents does not alter the effect of adult children's education on parental health in Western societies or in Asian societies such as China.

7.4 INTERACTION EFFECTS CONCERNING THE EDUCATION OF ELDERLY PARENTS AND THEIR CHILDREN

Elderly parents, both males and females, with a low level of education and living with highly-educated adult children are more likely to report good health, although the interaction effect is only significant for females. However, no evidence was found that more-highly-educated parents living with highly-educated adult children are more likely to report good health.

In terms of mortality, elderly males, highly educated parents living with more-highly-educated adult children had a lower mortality risk than those with a lower educational level living with less-well-educated children, apparently benefitting more from their children's better education. This finding is consistent with those reported in an earlier study conducted in Taiwan (Zimmer et al. 2007). Chinese culture influences both the Chinese mainland and Taiwan. Children or other family members are still the main organisers, suppliers and financiers of health care for their parents in Chinese society. More-highly-educated children can afford better medical care and services for their parents, having easier access to advanced health-related information and a lifestyle that is beneficial to the health of the elderly (Friedman and Mare 2014, Torssander 2013). However, our interaction results concerning mortality (Tables 9 and 10) indicate that these protective effects tend to be more pronounced among elderly parents of children with a high level of education, especially males. Hence, the main effect of individual educational level on male mortality should be interpreted with caution because it may vary according to the educational level of co-resident children.

The interaction effects also indicate that elderly female parents with a higher level of education living with offspring with a low educational level are less likely to report good health, and that both males and females have a higher mortality risk, although these effects are not statistically significant. This could imply that the educational levels of parents and their offspring mutually affect health. It may be that highly educated parents need to give financial support to their less-highly-educated adult children rather than to receive help from them. Such downward intergenerational financial flow may compromise the health of parents, and this needs further study.

7.5 METHODOLOGICAL CONSIDERATIONS

The strength of this study lies in the use of extensive population-based cross-sectional and longitudinal survey data to examine the associations linking the socioeconomic status of individuals, the educational level of co-resident family members and the health of elderly people in Chinese context. The CLHLS data is the first representative survey data covering three elderly categories (younger older and oldest) in China (Zeng et al. 2010). The health indicators used proved to be high in validity and reliability for this data (Gu 2008). However, one weakness is the rate of attrition in the follow-up, which is quite normal among elderly respondents and a methodological difficulty common to all longitudinal studies of the elderly. Selection models were used to assess the significance of the problem in Sub-studies I and II, and the results confirmed the findings from the latent-growth model.

Latent growth curve model with the selection model, multinomial logistic regression and the Cox proportional regression model were used to examine the trajectories of physical and cognitive functioning, self-rated health and mortality risk among the elderly in China. Repeated measurements of physical and cognitive functioning allow the examination of inter- and intra-individual differences in changes over time (Singer and Willett 2003). One of the advantages of latent growth modelling is that it can specify a path model in which the slope factor (the rate of change) in itself is a predictor of the outcome and allows for different error terms over time (Duncan and Duncan 2004).

Physical and cognitive functioning were measured by means of ADL/IADL and MMSE based on face-to-face interviews: both measures are widely used in social epidemiological research on the elderly and have been validated in numerous studies (Back and Lee 2011, Zhang 2006). Household income was used as one indicator of socioeconomic status in Sub-study I, but it may not fully reflect the financial status of Chinese elderly people because most of them live with other family members and thus household income is associated with different living arrangements. To compensate for this, self-reported adequacy of financial resources was used to indicate the financial status of our elderly subjects. As in most observational studies, the inverse association between health and socioeconomic status may have compromised the results of this research. In particular, it should be noted that although full information maximum likelihood estimation and the selection model were used, our sample consisted of the oldest (80 years and over) participants and therefore there may be a health-selection effect given the higher mortality risk in this age group. Moreover, those who were dropped due to death might have suffered severe ADL and IADL disabilities just before they died, which could be associated with a lower socioeconomic status. It should be noted that measurement of ADL and IADL may indicate a mixture of physical limitations and environmental barriers and they are associated with living environment of the older adults in different social contexts. Thus, present findings in this study might partially be associated with context barriers rather than purely physical limitations and generalization of our conclusions to other social contexts should be carried out cautiously. Furthermore, some items (e.g., walking continuously for 1km, lifting a weight of 5kg, crouching and standing up continuously three times) used to measure IADL in this study might be more related with physical capabilities. Sensitivity analyse excluding these items generated results were comparable with the main conculsions of this study (results not shown).

The MMSE proved to be a valid measurement of cognitive functioning in Sub-study II. However, the results concerning the different education groups should be interpreted with caution because the distributions of the MMSE scores were not equal, and it may be a more sensitive measure among those with a high level of education (Muniz-Terrera et al. 2009). It is also possible that some unobserved confounding factors were not controlled for in the models. Elderly people with pre-existing illnesses may be more likely to move in with family members, for example, which might lead to biased causal associations between household resources and health status. Thus, there is a need for future studies based on the direct measurement of this process.

In Sub-studies III and IV the education of spouses and their children were only used as measures of the family's socioeconomic status because of the unavailability of other indicators such as income and occupation of children. Although self-rated health might reflect different expectations of health for different socioeconomic groups (Shmueli 2003), in this study the results for self-rated health were largely similar with those for mortality which is a more objective measure of health. Thus, differences in the sensitivity of reporting self-rated health in different socioeconomic groups seems not to be a major problem. The low proportion of elderly people with any education could have affected the statistical power of the analyses measuring the effect of spousal education on self-rated health. It should be noted that individuals with a higher socioeconomic status are more likely to marry people with a similar status, and their children are also more likely to achieve a higher socioeconomic position. For this reason, individual socioeconomic status, spousal education and offspring's education were introduced into the models simultaneously, and also tested the interaction effect between parental education and their children's education when predicting good self-rated health and mortality risk. However, given the unavailability of measures of children's income, occupation, and financial and emotional exchange between generations in this study, there is a need for in-depth investigation into the possible mechanisms linking economic and social support from children with the health of elderly people. Furthermore, family members' health behaviours might affect the elderly, but it was impossible to examine these effects because of the lack of information on such behaviours.

8 CONCLUSIONS

This study investigated the associations of individual socioeconomic status and spousal and offspring's education with health conditions among the Chinese elderly using extensive population-based longitudinal survey data. The results have narrowed the research gap concerning the association between the educational level of co-resident family members and self-rated health and mortality risk among elderly people in China. As a further contribution the study yielded new information on socioeconomic differentials in the trajectories of physical and cognitive functioning in a non-Western context.

Our results showed that socioeconomic status had different effects on physical and cognitive functioning. At baseline, higher levels of education and household income predicated better physical (IADL) and cognitive functioning, but were mainly not associated with the age-related rate of decline. Adequacy of financial resources and access to health services played an important role in the physical functioning of these Chinese elderly people.

With respect to our second research focus, spousal education was not significantly associated with self-rated health, but both males and females living with more-highly-educated children were more likely to report good self-rated health. Higher spousal educational levels were found to relate to a lower mortality risk only among males, but in the case of offspring, high education was associated with an almost 20-per-cent lower mortality risk among elderly males and females. A higher level of education and living with better-educated adult children were associated with a lower mortality risk than a lower educational level and living with less-well-educated children.

Our results on functional trajectories did not support the accumulation-of-advantage hypothesis, suggesting a diverging trajectory of socioeconomic inequality in health, or the age-as-a-leveller hypothesis, suggesting a converging pattern in health gaps. It would seem from the present study that elderly people with a higher socioeconomic status will maintain their health advantage in later life, and that the health gaps associated with different socioeconomic backgrounds will persist with age. However, both spousal and offspring's education were associated with health and mortality risk. It seems that the socioeconomic status of family members has a strong effect on health equality among elderly people. Health inequality taken into family members' socioeconomic resources deserves further investigation, particularly in Asian populations.

Socioeconomic inequality may typically lead to health inequality. There is no formal system of long-term institutional care in China at present, and functional disability and cognitive impairment are generally more prevalent in lower socioeconomic groups. The Chinese government has introduced a home-based healthcare programme for elderly people in recent years (Feng et al.

2012), giving them access at home to professional healthcare and services supplied by the community. The local government allocates allowances to those who find it difficult to purchase health services. Long term care insurance was initiated in some cities in 2016, however, given the rapid ageing of the population, the increasing life expectancy and the declining fertility, along with the changes in family structure, living arrangements and rapid urbanization, China's health and social-care services face major challenges. Overall, the results of this study highlight the need to decrease socioeconomic inequality, increase financial resources and improve access to healthcare services, especially in the lower social classes. The socioeconomic status of family members plays an important role in the health of the elderly, and their offspring's socio-economic position should be taken into consideration in future research on health inequality in ageing populations. Investment in education will not only change the lives of children in the future, but will also improve the health and wellbeing of ageing parents in China.

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