CHILDHOOD AND ADULTHOOD CONDITIONS IN RELATION TO MILD COGNITIVE IMPAIRMENT AMONG U.S. AND CHINESE OLDER ADULTS: A LIFE COURSE PERSPECTIVE

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DEDICATION

This dissertation is dedicated to my parents, Lihua Jiang and Xumu Zhang. Thank you for supporting me through this and being my most solid backing. Although we are more than 10,000 kilometers apart, I can always feel your love.

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ABSTRACT

Using two nationally representative datasets, Chinese Health and Retirement Study (CHARLS) and Health and Retirement Study (HRS), this dissertation mainly examined the associations between adverse childhood experiences (ACEs), adulthood educational attainment and various domains of late-life cognitive functioning among older adults in China and United States under the life course framework. Results from cox proportional hazard models revealed that for both samples, various ACEs, for instance family SES and interpersonal relations were significantly associated with higher risk of mild cognitive impairment in later life, reconfirming the life course perspective and accumulative disadvantage theory. For the Chinese sample, childhood hunger was a strong risk factor for the mental status domain of cognitive functioning in later life, while the U.S. sample was especially susceptible to early paternal death. Following that, using adulthood educational attainment as a moderator, the detrimental effects of ACEs were buffered effectively: for both samples, having an education of middle school/high school or above could greatly reduce the risk of episodic memory impairment in later life.

Moreover, dividing both samples into male and female groups, gender differences have been detected. Among the Chinese older adults, results revealed that males were more susceptible to mother-related ACEs, while females were influenced by ACEs of all aspects: childhood SES, early paternal death, hunger, and interpersonal relations. The protective effects of education were more significant for females. While for the U.S. sample, both groups suffered from the detrimental effects of various ACEs on late-life cognitive functioning, but the moderation of education only worked for females, greatly reducing the risk of mild cognitive impairment in later life.

Findings of this study suggest that for older adults in both China and U.S., adverse childhood experiences could have long-lasting impacts on cognitive functioning throughout the life course, and adulthood educational attainment as an important resource is especially necessary and effective for females to buffer the effects of childhood trauma. This paper could provide reference for future research in an array of fields that can have implications for optimizing cognitive aging.

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1.1. Late Life Cognitive Functioning

1.1.1. Normal Brain Aging and Late-life Cognitive Functioning

Aging in humans is accompanied by stereotypical structural and neuro physiological changes in the brain and variable degrees of cognitive decline. The effects of aging on the brain and cognitive functioning are widespread and have multiple aetiologies. As humans age, their brains shrink in volume, particularly in the frontal cortex. It has been widely found that the volume of the brain and/or its weight declines with age at a rate of around 5% per decade after age 40 with the actual rate of decline possibly increasing with age particularly over age 70 (Svennerholm, Boström, & Jungbjer, 1997). It is suggested that a decline in neuronal volume rather than number has contributed to the changes in an aging brain and that it may be related to gender, with different areas most affected in males and females (Murphy, Arnsten, Goldman-Rakic, & Roth, 1996). As our vasculatuchre ages, our blood pressure rises, the possibility of stroke and ischemia increases, and our white matter develops lesions. Memory decline also occurs with aging and brain activation becomes more bilateral for memory tasks: This may be an attempt to compensate and recruit additional networks or because specific areas are no longer easily accessed.

However, brain changes do not occur to the same extent in all brain regions. It is found that aging has the greatest effect on hippocampus and prefrontal cortex (Trollor & Valenzuela, 2001), and these regions are dynamically involved in complex processes such as memory, attention and behavioral functioning via biochemical pathways. Aging-related changes may reduce both the weight and volume of these regions, alter synaptic plasticity and are also associated with inflammation (Agrawal, Sridharan, Prakash, & Agrawal, 2012; Kolb & Gibb, 2011; Troller & Valenzuela, 2001). Despite the fact that neurogenesis facilitates the generation of new neurons and their integration into the surrounding neural networks into adulthood, it deteriorates as human age (Toni et al., 2007; Vivar et al., 2012). Moreover, when neurons die, they cannot be regenerated and thus lose complete function, which would disrupt the normal functioning of the related brain regions.

Such is usually described as the general principles and physical changes of normal brain aging. However, it is found that there are stark between-person differences in terms of timing and severity of brain aging (Wilson, Leurgans, Boyle, & Bennett, 2011). While some older adults experience minimal effect of aging on cognitive function and may sometimes even outperform younger adults, others experience severe and accelerated decline in cognitive function in multiple domains and even end up with cognitive impairment.

1.1.2. Mild Cognitive Impairment

Across the age continuum from middle to late life, cognitive functioning can remain normal, can decline into a state of mild cognitive impairment, and can progress further to dementia. Conceptually mild cognitive impairment has been proposed to describe the state of cognitive functioning that falls below defined norms yet falls short of dementia in severity: A syndrome defined as cognitive decline greater than expected for an individual's age and education level but that does not interfere notably with activities of daily life (Gauthier et al., 2006). Its prevalence in population-based epidemiological studies ranges from 3% to 19% in adults older than 65 years. Some people with mild cognitive impairment seem to remain stable or return to normal over time, but more than half progress to dementia within only 5 years. Mild cognitive impairment can thus be regarded as a risk state for dementia, and its identification could lead to secondary prevention by controlling risk factors such as systolic hypertension (Feldman & Jacova, 2005). The past several decades have witnessed considerable debate in the definition, classification, and conceptualization of this cognitive continuum with aging. There is still heated debate over whether mild cognitive impairment is an invariable prelude to dementia, whether it is the earliest stage of definable dementia, or whether there are predictably benign forms. Nevertheless, the significant research attention that mild cognitive impairment has received has advanced the assessment and management of this health problem.

Within the broad mild cognitive impairment framework, there have been a variety of reference terms, which are important for understanding the widely varying estimates of prevalence, incidence and outcomes that exist for mild cognitive impairment and its best-studied subtypes: Age-Associated Memory Impairment (AAMI), Age-Associated Cognitive Decline (AACD) and Mild Cognitive Impairment (MICa).

Crook et al. (1986) describe AAMI as a stage of gradual decline in memory among healthy individuals over the age of 50. The decline in memory was described to be troublesome, particularly in intellectually demanding activities, with quite modest behavioral deficits compared with those of dementia. The criterion was defined as 1 standard deviation (SD) below young healthy norms in terms of memory tests, with other cognitive functions unimpaired; however, there was no specification of the test instruments recommended. AAMI is the only construct that used the functioning of young subjects as the reference, and therefore presents the most overlapping with normal aging.

As for AACD, Levy (1994) proposed the concept to extend the cognitive effects of aging beyond the memory domain. He defined AACD as a disorder affecting one of the cognitive domains of learning, memory, attention, thinking, language or visuo-spatial function, with an onset over at least six months and with a requisite for confirmatory collateral history from a reliable informant. The criterion centered on a score at least 1 SD below the age-appropriate norms. There was no specification of the cognitive tests to be used and this criterion has been widely adopted.

Petersen and Skoog (1996) refined the term to amnestic mild cognitive impairment (MCIa) as a clinically-defined disorder of cognitive functioning. The criteria for MICa specify that there be memory problems, preferably corroborated by an informant, with impaired memory functioning on test, generally 1.5 SD below the age-appropriate norms. General cognitive functioning overwise is normal and activities of daily living (ADL) is normal. These criteria clearly require the application of clinical judgement, and there are no psychometric tests specified. MICa is usually adopted in the clinical diagnosis.

These subtypes of mild cognitive impairment reflect on the lack of widely agreed-upon consensus criteria while at the same time highlighting the importance of diagnostics of mild cognitive impairment. Apart from the clinical perspective, there is increasing academic interest in discussing the psychosocial factors associated with cognitive functioning decline as well as the incidence of mild cognitive impairment in later life.

1.1.3. Social Determinants of Cognitive Functioning

Research across a diverse set of fields have postulated several hypotheses to explain variation in cognitive function trajectories to understand the etiologic origins of subsequent cognitive disorders. Psychological theories argue that deterioration of fundamental psychological processes (i.e., sensory acuity) account for deficiencies in cognitive functioning (Wilson & Bennett, 2017), biological theories posit that exogenous influences such as chronic diseases influence impairments and deterioration of functional organs (Kim, Park, & An, 2019), and of particular importance is the sociological theory of cumulative disadvantage, which posit that differences in social environments account for observed differences in social environments account for observed differences in cognitive functioning (Arbib, 2005).

Both risk factors (factors that independently increase risk) and protective factors (factors that independently reduce risk) that influence variations in late-life cognitive functioning have been researched. One set of well-established risk factors include vascular-related characteristics such as BMI, obesity, diabetes, hypertension (Anstey, Lipnicki, & Low, 2008; Lu, Lin, & Kuo, 2009). Such macro and microvascular disease effects contribute to the development of abnormalities in late-life cognitive functioning (Philllips et al., 2000; Reynolds et al., 2001). Some studies also suggested that vascular risk factors are associated with inflammatory processes that can disrupt cognitive function and affect long term aging (Libby, Ridker, & Maseri, 2002; Campbell et al., 1997). Meanwhile, psychological health as the risk factor has also been examined, for instance, depression has been found to be related to late-life cognitive functioning (Aarsland et al., 2007; Cummings, 2005). Other mental health outcomes such as stress disorders and anxiety have also been identified as risk factors.

Studies have suggested that neurodegenerative disorders have prodromal periods characterized by pathological changes that can manifest several decades before the symptom onsets (Launer & Brock, 2004; Everson-Rose, Mendes de Leon, Bienias, Wilson, & Evans, 2003). Childhood conditions, identified as important indicators for late life health, have been investigated as potential risk factors (Wilson et al., 2005) for variations in late-life cognitive functioning for older adults.

Cognitive health disparities are thought to originate in childhood. Growing evidence suggest that various adverse childhood experiences, for instance childhood socioeconomic status (SES) and health status, are associated with health problems in late life (Hailey & Lachman, 2000; Pavela & Latham, 2016). It is found that early parental death, childhood SES and health status were related to lower cognitive functioning, depression and physical health problems in adulthood, and such relationship extends to late life (Laditka, & Laditka, 2018; St Clair, Croudace, Dunn, Jones, Herbert, & Goodyer, 2015). Advantaged childhood SES is found to be positively related to late-life cognitive functioning (Staff, Chapko, Hogan, & Whalley, 2016), childhood trauma has also been found to be related to cognitive functioning (immediate memory, language, and delayed memory abilities) (Petkus, Lenze, Butters, Twamley, & Wetherell, 2018; Schuitevoerder et al., 2013), and childhood health is likely a robust indicator for orientation, word recall, and backward counting in late life (Wang, Zhang, Rizzo, & Fang, 2018). Exposure to adverse childhood experiences is associated with increased anxiety levels and cognitive impairment, as these conditions disrupt the maturation of underlying brain networks (Chen & Baram, 2016).

Apart from the accumulating evidence which suggest that childhood play an important role in late-life cognitive functioning, adulthood has also been regarded as a period of great risk for cognitive impairment and dementia (Hughes & Ganguli, 2009), and should also be taken into consideration. Adulthood conditions usually included adulthood SES and health status (Carroll & Turkheimer, 2018; Hughes & Ganguli, 2009), and were found to be in close relationship to late-life cognitive functioning. It is suggested that adulthood SES was consistently linked to cognitive functioning decline: better occupation and education background lead to higher cognitive performance in late life (Karp, Andel, Parker, Wang, Winblad, & Fratiglioni, 2009; Sattler, Toro, Schonknecht, & Schroder, 2012). Several indices of adulthood physical health also predicted cognitive performance decades later, for instance smoking (Rusanen, Kivipelto, Quesenberyy, Zhou, & Whitmer, 2011), alcohol consumption (Sabia et al., 2018), obesity (Chuang et al., 2015), vascular health (Tuligenga et al., 2014) and physical activity (Chang et al.,2010). Internalizing disorders at adulthood also predicted late life cognitive functioning: depressive symptoms prior to old age was identified as having a dose-dependent relationship with cognitive functioning decline (Dotson, Baydoun, & Zonderman, 2010). Among adulthood factors, education attainment has been recognized as a key contributor to the development of cognitive reserve, even in case of or despite Alzheimer's Disease pathology. Empirical evidence showed that lower educational attainment predicted poorer cognitive performance in late life (Stern, 2002), and having none or only primary school was associated with a 60% higher risk of dementia (Livingston et al., 2017). From this perspective, adulthood education attainment could be considered as an effective protective factor against cognitive aging (Tucker & Stern, 2011).

1.1.4 Variations by Gender

Moreover, gender differences in cognitive functioning abilities have been reported from childhood through adulthood, and until late life. Findings that males on average outperform females on spatial tasks have been reported since the 1950s (Bieri, Bradburn, & Galinsky, 1958). Similarly, there is a long history of research detailing superior average female performance on some tests of verbal ability (Anastasi, 1958). Zaninotto and colleagues (2018) used data from England and estimated a linear growth curve model for cognitive decline over a time span of eight years. They found that females experienced less cognitive decline than males after controlling for other covariates, and lower education was associated with steeper cognitive decline.

Drawing on the life-course approach, the cumulative disadvantage theory posits that early-life adversities may differentiate individuals' experiences over the life course, such that disadvantaged social groups (e.g., the poor and minorities) in a social hierarchy system typically have worse health status than their advantaged counterparts (Braveman, 2006; Ferraro & Kelley-Moore, 2003). In a gender-hierarchical society that favors males, therefore, females might have more negative life experiences and worse health conditions than males over the life span. Living in a patriarchal society, females were structurally denied formal education in early life and high-skilled occupations in adulthood historically, and these educational and occupational opportunities could provide important cognitive practices for the development and maintenance of cognitive abilities (National Research Council, 2000), rendering females more vulnerable to cognitive problems than their male counterparts. A male/female comparison in terms of both ACEs as well as cognitive functioning would make sense.

1.1.5. China and U.S. --- Developing and Developed

At the same time, a cross-country comparison could be taken into consideration. Currently China has the world's largest older population, and the size of older population in the U.S. ranks third in the world. According to China State Council and National Bureau of Statistics and U.S. Census Bureau, the large older population in these two countries are projected to more than double in size from 2000 to 2030.The two countries face drastic changes in age distribution: the population pyramid for China is more rectangular, and top will be much heavier and wider, and the trend will move toward an inverted pyramid. While for the United States, the baby boomers are entering the old population, and the country is faced with burgeoning older populations. However, there are also differences when it comes to aging patterns. The aging speed for China is accelerating and has surpassed that of U.S.: It would take only 27 years for China's older population to rise from 7% to 14% of total population (2000 to 2027), and such change requires 69 years for the United States. There are also different aging stereotypes: for instance, a higher percentage of older population is employed in China, and for older people who are no longer working, they rely heavily on family and social support (Smith, Strauss, & Zhao, 2014). But in U.S., reliance on retirement pensions is much more pervasive and older adults are more likely to live alone (Kincannon, He, & West, 2015). Also, when it comes to views of aging, negative stereotypes such as illness, unattractiveness and depression are more likely to be prevalent in U.S., and it is believed that positive stereotypes are more common among Chinese aging population (Boduroglu, Yoon, Luo, & Park. 2006). Considering the different sociocultural environment and aging patterns, a comparison of U.S. and China aging population in terms of cognitive decline is worthy of being carried out.

1.2. Theoretical Background

1.2.1. Life Course Perspective: Concepts and Principles

The principal theory utilized in this study is life course theory. Essentially life course theory is a heuristic way to study the interactions between individual lives and social changes, conceptualizing lives within the context of families, society and historical time. Life course studies the frequencies and timing of changes in positions, generally of birth cohorts, and these changes are called events or transitions. Individual life course is characterized by sequences of transitions, for instance graduating, getting a job, and getting married. Such sequences of statuses are called trajectories and the time between transitions are called duration (Kok, 2007). Moreover, it is noted that individuals follow normative patterns regarding the proper behavior at certain ages, for instance education during teenage, followed by employment, marriage and parenthood. Such standard, social constructed patterns are called social pathways (Elder, Johnson, & Crosnoe, 2003). According to Elder and colleagues, the advocates of life course theory, the discipline "provides a framework for studying phenomena at the nexus of social pathways, developmental trajectories, and social change" (2003, p.10). To understand how life course theory operates, life course theorists put forward five core principles, based on research in social and behavior sciences.

The first is life-span development, inferring that human development and aging are lifelong processes. The principle claims that we can only current understand choices and behavior by taking into account experiences in earlier stages of life. Individual development does not stop when we reach 18 or 20, and as adults, people may and must experience fundamental biological, psychological and social changes, which are influential to later life (Johnson, 2001). This can occur at various levels: the cohort/generational level as well as the individual/familial level. For instance, one generation might transfer the historical circumstances that shapes its life history to the next (e.g., living through the civil rights movements). The timing and conditions under which earlier life events and behaviors take place (e.g., experience domestic abuse) might also cause chain reaction for individuals (e.g., vicious cycle of family violence).

Such view, with its recognitive functioning and emphasis on cumulative disadvantage, is particularly useful in understanding inequality in later life (O'Rand, 1996).

The second principle refers to human agency and personal control, that is, individuals are active agents under the influence of social structure, but also make decisions and set goals that shape social structure. According to Clausen, individuals are assumed to have the capacity to engage in planful competence, which refers to the thoughtful and self-controlled processes that underlie one's choices about institutional involvements and social relationships (1991). However, it should be noted that, the decisions and choices made also depend on opportunities and constraints, which conform to the agent principle put forward by Elder, that families and individuals modify their expectations and behaviors in response to changes in needs and resources. For instance, families in the Great Depression constructed, negotiated and traversed life course and experiences through expenditure reductions as well as multiple family earners.

The third principle takes sociohistorical and geographical location into consideration. The life course of individuals is shaped by the historical times and places they experience. Taking China's Cultural Revolution as an example. During this period, many young people were sent to the rural areas and forced into manual labor, therefore their life trajectories were changed. In this way, they were set apart from young Chinese of adjacent birth cohorts and those of similar age but not were not sent to rural areas (Zhou & Hou,1999). Moreover, geopolitical events (e.g., wars), economic cycles (e.g., bubble economy) and social ideologies (e.g., patriarchy) can alter people's perceptions and choices, therefore influencing their life development. That is to say, individual behaviors and decisions are not happening out of nowhere, as they interact with sociohistorical and geographical factors.

Another principle of life course theory is timing. According to Price, McKenry and Murphy, there are three kinds of timing: individual time, generational time, and historical time (2000). Individual time means the chronological age, presupposing that different periods of life, such as childhood, adolescence and old age would influence the individual position in society (Hagestad & Neugarten, 1985). Generation time refers to the cohorts in which individuals are group, for instance, individuals born in the 1980s and 1990s are called the Millennials. History time refers to prominent social changes or events as well as how these events influence individuals and families, for instance technological innovation. It is argued that the same events or experiences may affect individuals in different ways depending on when they occur in life course (George, 1993). For instance, it is found that early marriage tended to produce accumulation of life disadvantages, from socioeconomic hardship to the loss of education (Elder, 1998).

The last tenet emphasizes linked lives and social ties, arguing that individuals live their lives interdependently and sociohistorical influences are expressed through this network (Elder, 1998). On a macro level, events such as war could affect individual behaviors, maybe enrolling in military service, and this can significantly influence other familial relationships. Stressful events, such as the loss of a family member, might also exert influences on family relationships. Moreover, family members can also synchronize or coordinate their lives in terms of timing of life events, which sometimes generate tensions and conflicts. Research found that the timing of adult children's individual transitions, for instance, when to marry and have children, could generate problems if interfered with the demands and needs of aging parents (Hareven, 1996).

Apart from the above-mentioned five principles put forward by Elder, some other arguments are also worthy of notice, for instance, the ability to adapt to life course change varies with available resources in the form of social capital (Mitchell, 2000).

There is also the recognitive functioning of increasing diversity associated with aging, that is, the longer one lives, the greater the exposure to factors that affect the aging process.

1.2.2. Cumulative Advantage/Disadvantage

One of the core theories of life course perspective is cumulative advantage/disadvantage, which refers to a systematic tendency for inter-individual divergence in a given characteristic or capital (e.g., money, health, or status) with the passage of time (Dannefer, 2003), resulting from the interactions of social structures and implying to be a property of groups or collectives and not a property of individuals. The cumulative disadvantage/advantage ranks the members of the group in terms of the volume of those given characteristics combined, following the assumption that small differences early in life can widen over the life course, that is, advantages and disadvantages give rise to additional and accumulating dis/advantages (Melo, Guedes, Mendes, 2019). The concept resonated with popular folk sayings such as “success breeds success” and “the rich get richer, the poor get poorer,” but it goes beyond such sayings: it explicates how the tendencies often occur independent of merit and in some cases, with mathematical precision (Merton, 1968, 1988).

The cumulative advantage/disadvantage perspective also has strong intellectual resonance with social reproduction theory. Social reproduction theory sought to describe a set of stratification mechanisms, many of which in modernity operate through schooling and other institutions and that produce strong intergenerational continuities in class location (Eckert, 1989; Willis, 1977). It can be said that reproduction theory depicts advantage and disadvantage as beginning to cumulate during childhood and schooling, based on stratified educational and socialization opportunities. Some scholars, such as Bowles and Gintis (1976, 2002) have explicitly connected schooling and work as integrated elements in such a system of stratified social reproduction. Although the social reproduction perspective has been little concerned with trajectories of human development and aging, the potential link is obvious. If, for instance, education is a resilient mechanism through which class-based or other regimes of inequality are reproduced, then the diverging interindividual trajectories that lead to increasing intracohort inequality have their origins in education-based stratification in early childhood, and, it can be hypothesized, continue to be amplified through the life course.

1.2.3 Resource Substitution and Resource Multiplication

Adulthood educational attainment plays an important role in the path to well-being because education is a resource itself, and the human capital it indicates helps people generate other resources. Education is the resource that belongs to the individual, rather than being external to the person like one's job or income (Sen, 1997). Education preceded and influences employment, work, and income, acting as the key to position in the stratification system. Formal education develops skills and abilities of general values, also known as human capital (Becker, 1964). Education also develops effective habits and attitudes such as dependability, judgement, motivation and confidence (Kohn & Slomczynski, 1993). Higher levels of education could increase the individual sense of personal control (Mirowsky & Ross, 2003; Pearlin, Lieberman, Menaghan, & Mullan, 1981). In contract, the less educated may not have the resources necessary to achieve their goals, and therefore a sense of powerlessness and helplessness.

Based on this, Ross and Mirowsky put forward the “resource substitution” and “resource multiplication” frameworks. Resource substitution theory of education and health states that education is more important to the health of people who are otherwise disadvantaged (Ross & Mirowsky, 2006). Resource substitution happens when having multiple resources makes outcomes less dependent on the presence of any specific source, implying that education’s influence on well-being is greater for persons with fewer alternative resources than it is for the more advantaged. Generally, females have fewer socioeconomic resources than men, and they had less opportunities for paid employment, and less authority at work. Therefore, females might depend more heavily on education for well-being (Reynolds & Ross, 1998; Rojas, Araya, & Lewis, 2005), since education is a special source, it indicates resourcefulness, or the general ability to meet situations effectively. Education is a part of the individual and cannot be taken away from those who have it. Similar to education, the sense of control is also inherent in the individual, and it could mediate the conditional effect of education on well-being. In other words, a greater sense of control reduces females’ burden and distress more than males’, and this could also explain education’s interaction with gender, since education could enhance the sense of control.

When resources substitute, disadvantages would multiply. Individuals with the most resources are less dependent on any one of them for the well-being, and individuals with the fewest resources are most dependent on any one resource for their well-being. The absence of other resources means that females are especially dependent on education for well-being, and females with lower levels of education will suffer more than males, since they have fewer alternative resources to call on.

In contrast, resource multiplication suggests that the influence of education on well-being is greater for individuals with more resources. The advantaged groups gain most from the resources that they possess, so these resources multiply to perpetuate and augment their advantage. Therefore, males are predicted to benefit more from education than females, since female gain lower economic payoffs from education. Compared with well-educated males, female have less authority and autonomy and less earnings (Reskin & Pedavic, 1994). For instance, as explained by Ross and Mirowsky, in U.S. and other countries, females get lower returns to capital, since the average increase in earnings associated with one more year of education is smaller than for males (2006).

Therefore, the reproduction of inequality leads to the perspective of resource multiplication. In these views, education supposedly promotes the privileged while holding back the disadvantaged. Disadvantaged groups such as females and minorities receive fewer benefits from education because the ultimate goal of education is to maintain the status quo. The education system is portrayed as selectively benefiting and promoting individuals with advantaged statuses, while generally discouraging and oppressing the disadvantaged groups. If so, the combination of frustrated effort and poorer outcomes may reduce the benefits of education for females.

1.3. Empirical Background

1.3.1 Adverse Childhood Experiences and Late-life Cognitive functioning

Adverse childhood experiences (ACE), developed from the study by Felitti and colleagues (1998), originally consisted of only abuse and household dysfunctions. Additional measures such as peer victimization, parental relationships, death of close family members, family SES, health (for instance, overweight and disability), neighborhood violence, poverty, and childhood friendship were added in later studies and were found to be efficiently advancing the ACEs scale (Danese et al., 2009;

Finkelhor, Turner, Shattuck, & Hamby, 2013). ACEs are powerful predictors of health outcomes in later life, and a growing number of studies have concentrated on the effects of ACEs such as SES, food deprivation, and family relations when studying late-life cognitive functioning (Greenfield & Moorman, 2019; Lee & Schaffer, 2021), indicating that ACEs were associated with lower levels of cognitive functioning in late life.

Childhood Socioeconomic Status (SES)

Most studies researching on childhood conditions have focused on the relationship between childhood SES and adulthood/late-life health outcomes. It is reported that measures of childhood SES were associated with cognitive function and Alzheimer's disease (Everson-Rose et al., 2003). Childhood SES has been found to be positively associated with mid- and late-life cognitive function in the United States, European countries, and developing countries such as China (Beck et al., 2018; Melrose et al., 2015; Singh-Manoux, Hillsdon, Brunner, & Marmot, 2005; Turrell et al., 2002; Zhang, Liu, Li, & Xu, 2018). For example, Using the British 1946 birth cohort, Richards and Wadsworth (2004) found that exposure to poor material home conditions (e.g., dated structure, poor repair, uncleanliness, crowding, etc.) at age 4 was strongly associated with lower cognitive ability in childhood and adolescence; and the negative effects of poverty on measures of verbal ability, memory, speed, and concentration persisted into (i.e., age 53). In addition, both father's and mother's education were also found to be positively associated with cognitive function among older adults aged 65 and older (Glymour, Tzourio, & Dufouil, 2012; González et al., 2013). Most of these studies defined childhood (or early life) as the period before the respondents reached age 18.

Several studies have included measures of respondents' own SES in adulthood as control variables when testing associations between childhood SES and late-life cognitive functioning. Rogers and colleagues (2009) found consistent evidence that participants whose mothers had 8 years or less of education had increased risk for cognitive impairment. Melrose and colleagues (2015) revealed that childhood SES was associated with baseline scores on semantic memory, but not episodic memory or executive function, nor with changes in global cognitive functioning. Persons in the lowest quintiles of childhood SES consistently demonstrated greater decline in global cognitive functioning than persons in the highest quintile. Finally, Lee, Kawachi, Berkman, and Grodstein (2003) used data from a sample of U.S. women who were assessed every 2 years between ages 70 and 79 years. Results indicated that women whose fathers were farmers were at slightly elevated risk for cognitive decline on global cognitive functioning—but not on individual test scores—compared with women whose fathers were upper white-collars.

Childhood Nutrition

Recent studies have found that lower childhood cognitive ability was associated with the development of late-life dementia, suggesting that cognitive deficits in early life may put individuals at higher risk of cognitive impairment in late-life (Deary, Whiteman, Starr, Whalley, & Fox, 2004; Cohn-Schwarts & Weinstein, 2020). Thus, nutritional deprivation during developmentally important periods might have long-term negative effects on cognitive function. In a recent meta-analysis, individuals exposed to food deficiency during childhood had approximately 2-fold increase in risk for cognitive impairment compared to those who did not experience food deprivation (Wang, Xu, Li, Cao, Tan, & Yu, 2019). In line with these findings, severe food deprivation during the Chinese famine in childhood was associated with poorer cognitive performance and with a greater cognitive decline (Kang et al., 2017; Zhang, Liu, Li, & Xu, 2018). Food deprivation during childhood was also found to be in relation to late-life brain health in the Chicago Health and Aging Project (Barnes et al., 2012).

However, two studies took advantage of longitudinal data to investigate whether childhood nutritional deprivation was associated with late-life cognitive decline and reported conflicting findings. Mak, Kim and Steward (2006) found that for a sample of 290 African-Caribbean residents of London, childhood nutritional deprivation was associated with cognitive impairment at baseline, but not associated with cognitive decline over a three-year follow-up. In contrast, using a national sample with an average of 5.4 years of follow-up in the U.S., Huang et al. (2008) reported that a longer arm span was associated with lower dementia incidence for both men and women.

Childhood nutrition deprivation is also found to influence late-life cognitive functioning indirectly. Researchers have argued that education in childhood promotes brain growth in the formative years and enables the brain network to operate more efficiently, thus providing protection against cognitive decline in later life (Fritsch et al., 2007; Kaplan, Turrell, Lynch, Everson, Helkala, & Slaonen, 2001). Malnourished children might lack the energy and motor skills essential to thrive in school and thus complete fewer years of schooling, which in turn affects late-life cognitive functioning (Mendez & Adair, 1999). Moreover, the research linking childhood nutritional deficiencies with cardiovascular and metabolic conditions points to possible physical disease pathways. Cardiovascular and metabolic conditions are both associated with cognitive impairment, suggesting that childhood nutrition may set in motion a cascade of physical health problems resulting in cognitive impairment (National Research Council, 2000).

Childhood Health

An extensive literature documents how the disease environment in the early childhood influences adult health outcomes. Some infections may affect brain development among children, presumably resulting in impairment throughout life. (Holding & Snow, 2001). Childhood infections may also speed cognitive decline in old age, possibly through the effects of infection on later life cardiovascular health (Costa, 2005) or the effects of inflammation on adult neurogenesis (Ekdahl, Claasen, Bonde, Kokaia, & Lindyall, 2003). Case and Paxson (2009) also found that the burden of disease in childhood --- measured using either mortality rates by cause or the overall infant mortality rate --- was significantly associated with performance on cognitive tests in old age. Apart from diseases, some health behaviors, particularly physical activity, are neuro-protective, in that they are associated with higher levels of late-life cognitive functioning (Sibley & Etnier, 2003; Trudeau & Shephard, 2008). It is found that specific physical activities and sedentary behaviors in childhood were associated with higher levels of late-life cognitive functioning (Aggio, Smith, Fisher, & Hammer, 2016).

Early life brain health, which is usually indicated by childhood cognitive functioning, is also found to be protective against risk for dementia in late life (Boots et al., 2015; Dekhtyar, Wang, Fraglioni, & Herlitz, 2016; Stern, 2012; Lee, Richards, Chan, Chiu, Lee, & Lam, 2018). This is also frequently used as indices of cognitive reserve (Vuoksimaa et al., 2016); for example, higher levels of childhood cognitive functioning, which is reflected in education, is associated with greater resistance to Alzheimer's disease pathology (Barulli & Stern, 2013). People with more intellectual capacity could attain higher levels of education as well as occupational complexity and engage more frequently in intellectually stimulating activities, therefore enjoy higher levels of late-life cognitive functioning (Stine-Morrow & Basak, 2011; Gow, Corley, Starr, & Deary, 2012; Corley, Cox, & Deary, 2018).

Early Parental Death

The principle of life-span development emphasizes how individual development can be attributed to events that occurred early in life (Elder, Johnson, & Crosnoe, 2003). The linked lives principle of the life-course perspective emphasizes the interdependent relationships among family members (Hagestad, 2003). In terms of parent–child relationships, this principle implies that the individual characteristics and social resources associated with parents may influence the health and well-being of children (Gimenez, Chou, Liu, & Liu, 2013; Li, Fu, Xue, & Wang, 2019). This principle suggested that the death of a parent in childhood and adolescence might remove important social and economic resources from the bereaved offspring and subsequently affect their cognitive development over the life course.

Not much research has been conducted to assess the association between early parental death and cognitive health in older adults. Among the limited studies available, Person and Skoog (1996) observed an increased risk of dementia in a sample of Swedish older adults who experienced parental death before 16 years of age. Similarly, Wei and colleagues (2014) reported an elevated dementia risk among Chinese older adults who experienced the death of a parent early in life. Ravona-Springer, Beeri, and Goldbourt (2012) used a sample of Israeli males and found that experiencing crisis following early parental death was associated with increased dementia risk in late life. Another study conducted in a rural county in the U.S. state of Utah suggested that the impact of early parental death on the prevalence of Alzheimer's disease was moderated by the deceased parent's gender but not the bereaved child's gender (Norton et al., 2011). Fu has also found that childhood trauma is associated with adverse health outcomes, for instance between death of mother in childhood and cognitive impairment in late life (2019).

Interpersonal Relationships

Interpersonal relations, including family relations and peer relations have also been studied as important aspects of ACEs. The absent of close relations in childhood might remove important social and economic resources from the child and subsequently affect individual development over the life course. Positive family environments have lifelong implications for people's well-being. It has been documented that parental support and intact family structure predicted better health in adulthood and later life (Gilman, Kawachi, Fitzmaurice, & Buka, 2003; Larson & Halfon, 2013; Meadows, Brown, & Elder, 2016). For instance, children growing up with close family relations and in two-parent families tended to have better physical health, lower depressive symptoms, fewer chronic conditions and higher levels of cognitive function than those who did not (Anderson, 2019; Chen & Harris, 2019; Chopic & Edelstein, 2019; Ferrar, Schafer, & Wilkinson, 2016; Lee & Schafer, 2021). Several mechanisms have been introduced to link family relations to late-life cognitive function: Research in neuroscience suggested that exposure to positive emotions such as happiness might increase the activity in the prefrontal cortex, which is responsible for memory function (Lane, Reiman, Ahern, Schwartz, & Davidson, 1997). Early brain activity and structure are found to carry over into adult cognitive function (Wang, Paul, Stanton, Greeson, & Smoski, 2013), providing a potential mechanism through which family social well-being may have enduring effects on cognitive health. Second, family social well-being may influence brain and cognitive development by promoting ongoing opportunities for learning and social interactions (Rogoff, 1990). For example, responsive parenting, verbal openness, and emotional support in two-parent families promote mental stimulation and related process that are ideal for cognitive development (Carlson & Corcoran, 2001). Exposure to adult language and conversation with multiple parents can also benefit cognitive maturity through language and reasoning development (Lewis & Lamb, 2003; Romeo et al., 2018). Other research has shown that children who are raised with lack of parental care tend to have enlarged amygdale in adulthood (Lyons-Ruth, Pechtel, Yoon, Anderson, & Teicher, 2016).

Apart from family relations, peer relationships were also considered as important childhood conditions experiences. Friendships and other peer relationships in childhood are significantly related to various aspects of social and cognitive development, and general well-being. These included intellectual ability, coping and adjustment capacities, delinquency, criminality, physical activity, substance abuse, sleep, suicide, sexual behavior, and mental health (Andrews, Hanish, & Santos, 2017; Hamilton, Warner, & Schwarzer, 2017; Li, Kawachi, Buxton, Haneuse, & Onnela, 2019; Light, Mills, Rusby, & Westling, 2019). Furthermore, the child development literature showed that limited friendship experiences during childhood are linked to loneliness (Spithoven, Bastin, Bijttebier, & Goossens, 2018), as well as educational achievement (Lessard & Juvonen, 2018), factors known to be related to cognitive decline in later life. Given that social interaction with friends promotes cognitive development during childhood (Cooc & Kim, 2017), adverse childhood friendship experiences during this sensitive period may have lasting consequences for cognitive functioning throughout the life course. The negative effects of social isolation, operationalized as loneliness, cumulate over the life course (Cacioppo & Hawkley, 2009), and adverse friendship circumstances experienced during childhood were associated with trajectories of cognitive functioning throughout middle and late adulthood (Burr, Han, & Peng, 2020).

Moreover, childhood friendship circumstances were found to be closely related to the development and the establishment of social relationships and loneliness in adulthood (Sherman, De Vries, & Lansford, 2000). Early friendships provided children with opportunities to learn and practice their social skills, which laid a foundation for their later social relationships. Lack of adequate friendship experiences during childhood may have trapped some individuals in a vicious cycle of loneliness, marginalization, and frustration, which may lead to further defensiveness and maladaptive interactions with others. Considering that adult social isolation, especially the loneliness dimension, is associated with later-life cognitive functioning and childhood friendship experiences are associated with social isolation at subsequent stages of the life course (Lempinen, Junttila, & Sourander, 2018), that loneliness and social disconnectedness in adulthood are mechanisms through which childhood friendship experiences are related to adult cognitive functioning in later life.

1.3.2. Life Course Pathways from ACEs to Late-life Cognitive functioning

Research on the processes through which childhood conditions influences cognitive functioning decades later generally has drawn on concepts from life course epidemiology. Theoretical developments within life course epidemiology have posited sequences of associations among risk and protective factors that emerge throughout the life course and influence late-life health. One such sequence comprises a pathways model. This model suggests an indirect effect whereby childhood conditions influence social and economic trajectories throughout young adulthood and middle age, which therefore subsequently affect late-life outcomes (Lyu & Burr, 2016). For instance, studies have found that individuals with higher SES in childhood were more likely to obtain a postsecondary degree, and postsecondary degree completion in young adulthood was associated with subsequent advantages throughout adulthood (e.g., higher status occupation, healthier lifestyles) (Lawrence, 2017). Such advantages in adulthood potentially contribute to lower risk for poor cognitive functioning in late life.

An alternative sequence is reflected in a latency model, which suggests that childhood exposures have direct and immediate biological effects that influence late-life health outcomes independent of other experiences and exposure to risk factors during adulthood (Lyu & Burr, 2016). This model is consistent with theorizing on sensitive periods, which posits that there are specific stages of the life course during which organisms are highly susceptible to contextual conditions. Prenatal, early childhood, and adolescences have been identified as especially sensitive periods for neurological development; the organization of the brain at these developmental stages might have long-lasting effects on cognitive outcomes, regardless of subsequent exposure to other risk and protective factors (Seifan, Schelke, Obeng-Aduasare, & Issacson, 2015).

Within descriptions of these life course processes, scholars generally acknowledge that both latency and pathway models can be operational. When considering cognitive outcomes specifically, simultaneous casual processes are especially likely because of reciprocal influences among the brain, environments and human behavior. Neuroscientific theorizing on life conditions has characterized the brain as "a major locus of integration and influence for the multitude of environmental factors that shape our lives" (Farah, 2018), while environments encompass both physical and social factors that are highly correlated with life conditions (e.g., life event stress). At the same time, it is also found that the development of fundamental cognitive skills, including both academic and socioemotional, can influence one's future socioeconomic positions (Spengler, Brunner, Damian, Ludtke, Martin, & Roberts, 2015). This theorizing suggested the importance of considering subsequent adulthood conditions when examining life course processes from childhood conditions to late-life cognitive functioning.

1.3.3. Adulthood Educational Attainment

As childhood conditions set in motion adult achievement processes and exposures largely through the critical life experience of education, it is important to understand how childhood conditions and education combine to influence late life cognitive functioning. Education is chosen as the key marker of adult context for several reasons: Educational is highly correlated with numerous dimensions of adult life – such as health-related behaviors, social ties, and psychological well-being --- and it is causally prior to other dimensions of SES (Mirowsky & Ross, 2003). Meanwhile, Education is also a potentially powerful policy lever. For instance, public expenditures on education in the United States have the most substantial impact on state-level mortality rates compared with other public services, such as environment and housing, welfare, health and hospitals (Dunn, Burgess, & Ross, 2005).

The influence of education in later life outcomes is well established in many disciplines and is the focus of many health outcomes (Galama, Lleras-Muney, & Kippersluis, 2018). Education is a key through which social class is reproduced across generations, providing economic, social, and cultural capital, and indelibly influencing dispositions and behaviors (Bourdieu & Wacquant, 1992). For the past decades the inverse associations between education and health have been documents (Hummer & Lariscy, 2011), and its persistence across time and space suggests that education is a flexible and powerful resource that would allow individuals to avoid health risks and adopt healthy lifestyles regardless of time or place, such that the association persisted even if the mechanism change (Link, 2008). For instance, education provides favorable economic and material conditions, greater psychosocial resources such as salubrious social ties and a sense of control, and healthier lifestyles (Ross & Wu, 1995) --- factors that in turn would promote health. Indeed, several recent studies suggested a causal role of education on health (Baker, Leon, Smith Greenaway, Collins, & Movit, 2011; Glymour, Kawachi, Jencks, & Berkman, 2008; Lleras-Muney, 2005). Of course, other socioeconomic resources such as income and occupation have also been found to shape health, education is causally prior (Mirowsky & Ross, 2003), and its association with health often remains after adjusting for these resources (Baker et al., 2011). Most importantly, education-related information is usually available for all adults regardless of employment or age, and education is relatively stable across the adulthood life course.

Based on this, there has been multiple studies concentrating on the positive association between educational attainment and aging-related cognitive decline (Chen et al., 2019; Clouston, Kuh, Herd, Elliott, Richards, & Hofer, 2012; Wilson, Yu, Lamar, Schneider, Boyle, & Bennett, 2019). The strong association may stem from a variety of sources, including ability-based selection into education, lasting acquired knowledge during the education process, and education-induced changes in brain function that could buffer the effects of neuropathology and thus help maintain higher levels of cognitive functioning (Alley, Suthers, & Crimmins, 2007; Diamond, 1988; Richards & Deary, 2005). Education is thereby instrumental in avoiding functional impairment, either through higher initial levels of cognitive functioning relative to clinical manifestation of impairment (passive models) or through improved compensatory use of brain networks, with are less susceptible to disruption (active models). However, some studies have shown little to no link between education and cognitive abilities later in life (Glymour, Tzourio, & Dufouil, 2012; Zahodne et al., 2011).

A major component of this debate in educational attainment's role in cognitive functioning is due to whether education is a correlational or causal factor (Schneewei, Skirbekk, & Winter-Ebmer, 2014). For example, the association between these two factors could be a result of reverse causation, where high levels of cognitive ability in early life may influence educational attainment. However, education is something that could be influenced by a myriad of unobserved characteristics, which in turn could impact cognitive functioning in later life. A large literature has focused on the causal role education plays in childhood cognitive functioning, which ultimately could influence these same characteristics later in life (Clouston et al., 2020; Davies et al., 2018; Deary & Johnson, 2010). Furthermore, there are several suggestions that higher levels of education in life not only affect cognitive ability but also may attenuate aging-associated declines in cognitive functioning, although there is doubt regarding the latter (Lövdén et al., 2020).

Human capital theory posits an impact of education on health through pathways such as economic resources, a sense of personal control, and health-producing behaviors (Mirowsky & Ross, 2003). Empirical studies suggested that higher levels of education improved adult health, independent of early-life socioeconomic conditions (Best, Hayward, & Hidajat, 2005; Hayward & Gorman, 2004). In the cognitive functioning literature, having formal education has been indicated to significantly reduce the risk of cognitive impairment in older men and women (Zhang, Gu, & Hayward, 2008). Education has also been identified as a powerful confounder that attenuated the impact of demographic characteristics and life styles on cognitive performance (Akbaraly, Singh-Manoux, Marmot, & Brunner, 2009; Masel, Raji, & Peek, 2010). Yet, it is quite understudied whether education would potentially moderate the association between early-life trauma and cognitive functioning in late life.

1.3.4. Gender Matters --- Variations by Male/Female

Both theory and empirical evidence regarding the link between ACEs, education and later-life cognitive functioning suggested that historically prevailing gender differences in access to education play a key role in explaining gender disparities in later-life health, including cognitive functioning. One frequently asked question is why males and females often have different health statuses. It is known that females generally live longer than males, a pattern that also seems to prevail among other species, and females are less likely to die from most major cause-specific diseases (e.g., heart diseases, cancer, and diabetes). However, females tend to suffer from more physical illnesses and limitations than males do, a phenomenon known as the health-survival paradox (Austad & Fischer, 2016). This paradox might be caused by mortality selection among males (e.g., males with severe health issues die earlier) or differences in types of health issues prevalent among different gender groups.

Male-female health differences seem to hold true for late-life cognitive functioning as well. According to World Alzheimer Report (2015), More females suffered from Alzheimer's disease or other types of cognitive impairment than males in almost all age groups across the globe. This is potentially due to various factors, of which men and women have different distributions, affect cognitive functioning in both positive and negative ways (Mielke, Vemuri, & Rocca, 2014; Nebel et al., 2018; Rieker & Bird, 2005). Gender differences in cognitive impairment have been approached considering both biological and social factors: While biological factors (e.g. effects of gonadal hormones) can cause gender differences on health, particular cognitive impairment, behavioral risk factors and social determinants also seemed important in explaining such differences (Denton, Prus, & Walters, 2004; Moss, 2002; Podcasy & Epperson, 2017; Short, Yang, & Jenkins, 2013).

Acquired risks and health behaviors may also account for gender differences in cognitive impairment. As cardiovascular risks are associated with the onset of dementia, health behaviors which influence these risks can play mediating roles (Kim, Kim, Hong, Lee, & Jung, 2018). In fact, health behaviors such as exercise, smoking habits, and diet, have been associated with the risk of cognitive impairment (Anstey, von Sanden, Salim, & O'Kearney, 2007; Sofi et al., 2011). Previous studies suggested that behavioral determinants were more significant in men, and men tend to be more engaged in risk behaviors for chronic conditions, while women were more likely to engage in preventive behaviors, such as keeping a healthy diet, not smoking, and accessing health services (Kautzky-Willer, Harreiter, & Pacini, 2016; Moss, 2002).

Other than that, social characteristics (e.g. education, occupation, and economic conditions) have also been studied as important determinants for cognitive impairment in later life for different gender groups (Denton, Prus, & Walters, 2004; Mielke, Vemuli, & Rocca, 2014; Rieker & Bird, 2005). Socioeconomic inequality among men and women has been rooted in many factors, such as economic, political, historical, and social arrangements, and affects health and wellbeing via health-related mediators (e.g. social, institutional, and psychosocial factors and health behaviors), which are related to behavioral factors (Adler & Newman, 2002). From the perspective of life-course approach, biological factors were strongly affected by exposure to adverse circumstances during critical developmental periods, such as in utero, infancy, and early childhood (Ben-Shlomo & Kuh, 2002). Socioeconomic disadvantage measured by education is indirectly associated with an increased risk of dementia via psychological distress (Hasselgren et al., 2020). From this perspective, females were disadvantaged from the childhood through adulthood, and therefore would tend to end up with higher risks of cognitive impairment in later life.

1.4. U.S. and China: Compare and Contrast

With the global aging of the population, cross-national comparison provides a unique perspective to gain knowledge on the similarities and differences in the ageing experience. China and the U.S. present interesting comparative examples to policymakers and researchers to identify factors influencing older adults' health. These two countries have shown similar trends in aging and health: More people are living longer with multiple chronic conditions, and cardiovascular disease, lung disease, cancer and stroke have become the leading causes of death (He, Goodkind, & Kowal, 2016). Meanwhile, the two countries may have different patterns in demographics and health risk factors.

China, as the most populous country and with the second-largest economy, has 18.34% of the world population in 2018. No other country in the world is experiencing population aging on the same scale as China. Life expectancy has increased steadily during the past half century: In 1960, average life expectancy at birth in China was around 44 years. By 2017, it had increased to 76 years (World Bank, 2018). Physical and cognitive health among older adults is also improving with rising educational attainment and better medical care (Smith, Strauss, & Zhao, 2014). These life expectancy gains and reductions in disability, however, are linked to rapid economic development in urban areas. Older adults in rural areas have not fared as well, leading to growing rural-urban disparities in health (Liu et al., 2019). Families have traditionally been the major source of financial and caregiving support for older adults in China, and most older adults have children living with them or nearby who can provide caregiving assistance. However, China's relatively low fertility rate will reduce the availability of family caregivers in the future (Smith, Strauss, & Zhao, 2014).

Home- and community-based services could help fill the caregiving gap by providing older adults with medical, rehabilitation, and other healthcare services. These kinds of paid services are increasing but are not widely available, even in cities (Feng, Liu, Guan, & Mor, 2012). As the demand for home-based care increases, the cost of providing that care will also increase with the rising number of disabled older adults. These costs include paid medical and nursing services, as well as opportunity costs for unpaid family members or friends who are providing care.

At the same time, there are increasing rural-urban disparities in terms of aging: in the poorer rural counties, half of adults ages 45 and older reported being in poor health in 2011-2012, compared with 9% in better-off urban counties (Smith, Tian, & Zhao, 2013). And there are wide gender gaps in health: Older Chinese women fare worse than men across a wide range of health measures. Persistent gender gaps in education and literacy are partly to blame for older Chinese women's poor health relative to men. Researchers have also identified wide gaps in the cognitive abilities of older men and women. These gender differences in cognitive ability are decreasing as educational attainment increases among Chinese women in younger cohorts (Lei, Smith, Sun, & Zhao, 2014). These health challenges will be exacerbated by rapid demographic changes, and these challenges are shared by leaders in many other developing as well as developed countries that have experienced rapid declines in fertility and mortality in recent decades.

For the United States, the current growth of the population ages 65 and older, driven by the large the baby boom generation, is unprecedented in U.S. history. As they have passed through each major stage of life, baby boomers (between ages 55 and 73 in 2019) have brought both challenges and opportunities to the economy, infrastructure, and institutions. According to U.S. Census Bureau, the number of Americans aged 65 and older is projected to nearly double from 52 million in 2018 to 95 million by 2060, and the 65-and-older age group's share of the total population will rise from 16% to 23 %. As a culturally and racially diverse society, the older population in U.S. is becoming more racially and ethnically diversified. Between 2018 and 2060 the share of the older population that is non-Hispanic white is projected to drop from 77% to 55%. There are positive developments in terms of the aging population: Education levels are increasing. Among people ages 65 and older in 1965, only 5% had completed a bachelor's degree or more, and by 2018, this share had risen to 29 percent. Moreover, average U.S. life expectancy increased from 68 years in 1950 to 78.6 years in 2017, in large part due to the reduction in mortality at older ages. The gender gap in life expectancy is also narrowing: In 1990, a seven-year gap in life expectancy existed between men and women, but by 2017, this gap had narrowed to five years (76.1 years versus 81.1 years) (Murphy, Xu, Kochanek, Curtin, & Arias, 2018).

While at the same time there are also challenges: Wide economic disparities are evident across different population subgroups. According to U.S. Census Bureau (2018), Among adults ages 65 and older, 17% of Latinos and 19% of African Americans lived in poverty in 2017—more than twice the rate among older non-Hispanic whites. More older adults are divorced compared with previous generations: The share of divorced women ages 65 and older increased from 3% in 1980 to 14% in 2018, and for men from 4% to 11% during the same period. Moreover, the aging of the baby boom generation could fuel more than a 50% increase in the number of Americans ages 65 and older requiring nursing home care, to about 1.9 million in 2030 from 1.2 million in 2017. Still research has documented that community-based programs and policies can successfully improve function and quality of life among older adults through interventions designed to increase physical activity, prevent falls, and improve functioning (Anderson, Goodman, Holtzman, Posner, & Northridge, 2012). Data from Alzheimer's Association (2019) show that demand for elder care will also be driven by a steep rise in the number of Americans living with Alzheimer's disease, which could more than double by 2050 to 13.8 million, from 5.8 million today. The large share of older adults also means that social security and Medicare expenditures will increase from a combined 8.7% of gross domestic product today to 11.8% by 2050.

The large older populations in these two countries are projected to more than double in size over the next three decades. Considering the important roles of different sociocultural backgrounds in health and aging process, it is particularly important to understand how factors including demographics, health patterns, family and sociocultural environments influence health among older adults in China and the USA. Taking this into consideration, this study aims to use nationally representative samples of U.S. and China older population to investigate the similarities and differences when it comes to how life conditions influence late-life cognitive functioning.

1.5. Research Aims and Questions

In the face of numerous research on how ACEs and adulthood conditions influence late life cognitive performance, there remain several important gaps in this literature. In particular, the literature seldom studied both ACEs and late-life cognitive functioning as multidimensional factors and most studies focused solely on one aspect (for instance, SES or mental health). Apart from that, the literature had not applied a complete life course framework into understanding the transitions between life course processes and has not yet investigated the frameworks linking childhood conditions to adulthood conditions that may work simultaneously to influence late-life cognitive functioning:

possible interaction between ACEs and adulthood educational attainment have not been taken into consideration. In addition to that, the possible differences in terms of the focal relationship for different gender groups as well as older adults living in different cultural contexts should be taken into account.

Therefore, to fill in such gaps, this study aims to advance understanding of life course processes through which childhood conditions influence late-life cognitive functioning by further orienting to adulthood conditions. Moreover, comparative studies that consider such relationships for two gender groups as well as under two cultural backgrounds would be carried out.

This study aims to examine four research questions, which are related to each other. Considering the late-life cognitive decline and impairment among older adults, the first research question is:

Research Question 1: Describe the general cognitive functioning conditions as well as mild cognitive impairment of older adults and discuss the disparities for older adults from different groups (gender, race, place of residence etc.).

Following that, guided by concepts from life course epidemiology, this paper traces back to childhood conditions to explain the risks of mild cognitive impairment as well as various subsections of cognitive functioning and to answer the following question:

Research Question 2: How are adverse childhood experiences (ACEs) associated with risks of mild cognitive impairment of older adults? What about the two domains of cognitive functioning (episodic memory and mental status)?

Furthermore, this paper aims to investigate the moderating role of adulthood educational attainment and answer the following question:

Research Question 3: Does adulthood educational attainment to some extent influence the association between ACEs and risks of mild cognitive impairment? If so, what are the influences?

Meanwhile, guided by resource substitution theory, this paper also tends to examine whether and how the associations between ACEs, adulthood educational attainment and mild cognitive impairment differ among males and females. The following questions would be answered:

Research Question 4: Are there any gender differences in the above-mentioned associations?

Lastly, how the focal relationships across cultural backgrounds (U.S. and China) would also be investigated to answer the following question:

Research Question 5: What are the similarities and differences between older adults from U.S. and China in terms of the above-mentioned associations?

1.6. Chapter Introductions

This dissertation is made up of five chapters. The first chapter is the introduction of theoretical and empirical backgrounds, as well as the research questions of the study. In Chapter 2, the focus would be on older adults in China. Using four waves of the China Health and Retirement Longitudinal Study, Cox proportional hazard models were employed to estimate the associations between various ACEs and risk of mild cognitive impairment in later life. ACEs and adulthood characteristics were included separately and simultaneously in the models to test the possible moderating effects of adulthood educational attainment on the focal relationships. In addition to that, cognitive functioning was also divided into two domains: episodic memory and mental health. Cognitive functioning domain analysis and male/female analysis were carried out.

In Chapter 3, to facilitate China-U.S. comparison, similarly four waves of data from Health and Retirement Study were used, and Cox proportional hazard models were carried out. The total score system was slightly different from that of the Chinese survey, still cognitive functioning was divided into domains of episodic memory and mental health. Using the same mild cognitive impairment criteria as well as similar set of ACEs, how childhood conditions together with adulthood educational attainment influenced late-life cognitive functioning was estimated. Possible cognitive functioning domain differences and gender differences were also discussed.

In Chapter 4, comparison and contrast of the results from Chinese and U.S. sample analysis were the main focus. Similar baseline sample characteristics, as well as common significant ACEs were summarized. Moderating effects of education were also included. In addition, the different significant ACEs and moderation effects were compared and cultural-related interpretation and discussion was provided. Lastly, in Chapter 5, answers to each research question were provided, general implications and future research directions were also discussed.

CHAPTER 2: Adverse Childhood Experiences, Adulthood Educational Attainment and Mild Cognitive Impairment in Later Life: Exploring Gender Differences Using CHARLS

2.1.Introduction

Rapid population aging drew global attention in the last decade primarily because of the challenges it brings to the labor market and to public health (Feng, Hong, Qian, Wu, & Shi, 2020; Harper, 2014). Cognitive functioning is regarded as one of the most important health conditions, and its decline with age is a major concern for older adults when it comes to functional independence and effective communication (Zaninitto, Batty, Allerhand, & Deary, 2018). Some gradual cognitive declines are seen with normal aging, for instance, the ability to learn new information may be reduced. These declines do not affect overall functioning or abilities to perform activities of daily living. However, more severe declines often lead to mild cognitive impairment, a point along the pathway to dementia (Murman, 2015). Studies found that approximately 16% of older adults have mild cognitive impairment and 14% experience dementia after the age of 70 (Morely, 2014; Petersen, 2016). The study of risk factors of mild cognitive impairment is therefore of great importance.

Common risk factors for cognitive decline and cognitive impairment include education (Leibovichi, Ritchie, Ledesert, & Touchon, 1996; Alley, Suthers, & Crimmins, 2007), socioeconomic status (SES) (Everson-Rose, Mendes, Bienias, Wilson, & Evans, 2003; Xu et al., 2016), social engagement (Krueger et al., 2009), and physical health, including stroke, hypertension, body mass index and diabetes (Arvanitakis, Capuano, Bennett, & Barnes, 2017; Reitz, TRabgm Manly, Mayeux &

Luchsinger, 2007; Zilliox, Chadrasekaran, Kwan, & Russell, 2016). Recently, a growing body of studies have started to focus on adverse childhood experiences (ACEs) that might increase risks for serious health problems and higher mortality rates in late life (Felitti et al., 1998; Finkelhor, Turner, Shattuck, & Hamby, 2013). Indeed, from the perspective of life course, ACEs such as early parental death, childhood SES and health status are related to cognitive functioning in adulthood, and such relationship could extend into later life (Laditka, & Laditka, 2018). It is documented that childhood SES was negatively related to late-life cognitive impairment (Greenfield & Moorman, 2019), childhood health was a robust indicator for episodic memory, and backward counting (Wang, Zhang, Rizzo, & Fang, 2018), and childhood adversities such as early parental death significantly could increase the risk of severe cognitive impairment in late life (Fu, 2019).

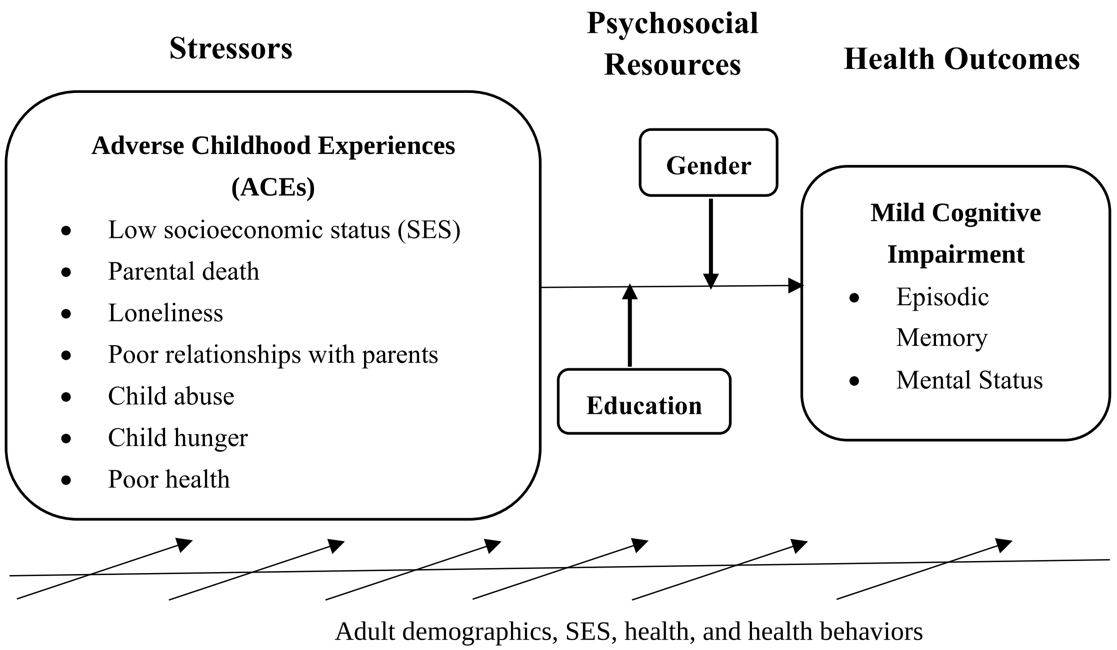
Despite the accumulating evidence on how ACEs might affect cognitive impairment in late life, most studies were conducted in Western societies. Very few studies have focused on the middle- and old-aged adults in China, and it remains unclear whether the negative effects of ACEs on cognitive impairment persist among this rapidly increasing aging population. Throughout the 20th century, many older Chinese adults experienced impoverished childhood conditions, such as hunger and wars, which could have long-lasting impacts on their cognitive functioning. There are some studies investigating the associations between ACEs and cognition among older Chinese adults: Using cross-sectional data, it was found that childhood SES and nutrition were related to cognitive decline (Zhang, Liu, Li, & Xu, 2018); Zhang and colleagues (2008) focused on the oldest old population in China and found significant influence of childhood SES on cognitive decline; Yang and Wang (2020) focused on age disparities and concluded that detrimental impact of ACEs was persistent throughout later life. Still, to my knowledge, few studies have examined how ACEs could affect mild cognitive impairment among Chinese older adults, and this study aims to fill in this gap. Moreover, this study is interested in the two domains that make up the total cognitive functioning: episodic memory and mental status. Episodic memories refer to facts, rules, and basic knowledge about the world, while mental status refers to the single events or personal experiences that contain information about the spatial and temporal context of events (Squire, 2004). How various ACEs influence the two domains of cognitive functioning differently would also be one focus of the study.

Meanwhile, formal education in adulthood life is another important marker of cognitive functioning. Lower education has been related to a higher risk of dementia, possibly due to greater vulnerability to brain pathology in aging (Katzman, 1993; Caamano-Isorna et al., 2006). Compared to no education, even a few years of education is related to lower risk of cognitive impairment (Farfel et al., 2013). Although the association of education with dementia risk has been well-established, whether education attenuates cognitive decline is still an ongoing debate. Earlier finding reported an association between more education and reduced cognitive decline (Evans et al., 1993; Lee, Kawachi, Berkman, & Grodstein, 2003), whereas more recent studies have shown that education was associated with the level of cognitive function but not the rate of cognitive decline (Wilson et al., 2009; Zahodne et al., 2011). These findings suggest that the association of more education with improved cognitive performance may account for the association between education and the risk of dementia. Recent studies have also shown that this association is mainly driven by domain-specific cognitive skills, but not more elementary abilities such as processing speed (Ritchie, Bates, Der, Starr, & Deary, 2013; Ritchie, Bates, & Deary, 2015). There is limited research on whether adulthood educational achievement could modify the detrimental effect of ACEs on various domains of late-life cognitive function. One hypothesis is that the effect of ACEs could be attenuated or buffered in more educated people, since longer formal education might help establish better skills and regulatory capacities, thus stimulate engagement in an active lifestyle throughout adulthood (Zhu, Qiu, Zeng, & Li, 2017), and this study aims to test the hypothesis.

Moreover, exposure to and health consequences of ACEs may differ by important demographic factors in China. Gender is another important factor in the Chinese cultural context as there are significant differences in gender roles, opportunities, and obligations for males and females throughout the life course (Zhang, 2006). Due to the patriarchal gender structure in the Chinese society, the current cohorts of older females, especially those in rural areas, were disadvantaged in many ways throughout their lives compared to males (Pearson, 1995). In traditional agricultural-based Chinese families, parents often favored sons over daughters. Under this patriarchal social background, females had fewer access to education, nutrition, and cognitive stimulating activities in earlier life, and these were all associated with cognitive development and maintenance (National Research Council, 2000). Parish and Willis (1993) found that there were large gender gaps in schooling for Chinese rural families, and such gender differences in education may result in cognitive disadvantages for Chinese females (Lei, Smith, Sun, & Zhao, 2014). A growing body of studies have confirmed that Chinese females were significantly disadvantaged in cognitive functioning in old age (Gu & Qiu, 2013), while few have explored the role of ACEs. An early study (Yu et al., 1989) reported that there were large gender disparities in the prevalence of both severe and mild cognitive impairment among those aged 65 and older in Shanghai. Lei and colleagues (2014) revealed large gender cognitive differences that were mitigated by disparities in education, and such differences were especially concentrated among older age groups and economically disadvantaged communities. Older Chinese females had relatively fewer resources and less power to avoid an impoverished childhood and might face higher risks of cognitive impairment than their male counterparts. At this stage, few studies have explored empirically the early life factors that could account for the significant gender differences in mild cognitive impairment in China. Thus, the added value of this study is to examine gender disparities in the association between ACEs and mild cognitive impairment for Chinese old-aged adults.

Taken together, this study aims to make three major contributions to the understanding of the association between ACEs and cognitive functioning in later life. First, despite many studies on cognitive functioning, this study is among the first to investigate the longitudinal relationship between various ACEs and mild cognitive impairment. Mild cognitive impairment is different from cognitive decline in that it is the stage between expected normal cognitive decline with aging and the serious impairment as dementia, and it pertains to the earliest manifestations of Alzheimer's disease (Knopman & Petersen, 2014). Second, using nationally representative longitudinal data, this study provides new evidence about how ACEs and adulthood education work together to influence mild cognitive impairment in China, a country with the largest aging population embedded in a unique historical, cultural, and social context. Third, this study aims to examine the possible gender disparities in the above-mentioned relationships, adding to the body of literature on subgroup variations. The conceptual framework of this study is shown in Figure 2-1.

Figure 2-1. Conceptual Framework Linking Various Aspects of Adverse Childhood Experiences (ACEs) with Mild Cognitive Impairment in Later Life



2.2.Methods

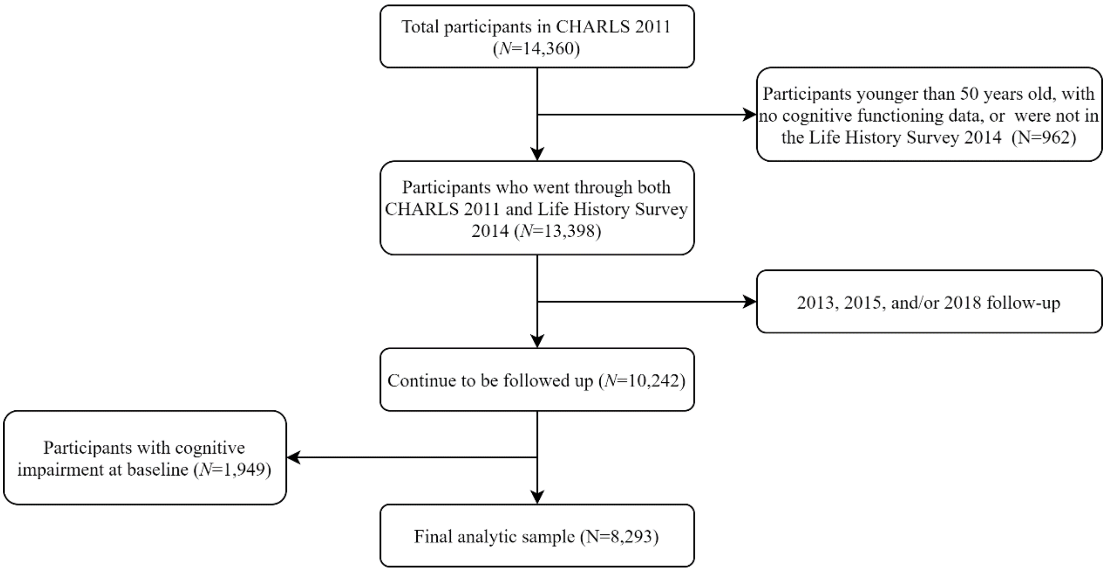
2.2.1. Data

This study is based on four waves of survey data as well as the life history data from the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is a nationally representative panel study conducted by the China Center for Economic Research of Peking University. The baseline survey recruited respondents (45+ years of age) randomly selected from 150 counties using multistage probability sampling in 2011 and then three follow-up surveys were conducted in 2013, 2015 and 2018 respectively. The CHARLS collected information on a wide range of topics, including demographics, family structure, social networks, health and insurance, pensions and property. The life history survey was carried out in 2014 and collected detailed information about the childhood and adolescence experiences of respondents, including childhood SES, interpersonal relationships, education history, health and neighborhood qualities. All data were collected using face-to-face computer-assisted personal interviews and had a response rate over 80% at the baseline (Zhao, Hu, Smith, Strauss, & Yang, 2012). The study was approved by the Ethical Review Committee of Peking University, and all participants signed written-informed consent forms.

2.2.2. Study Sample

There were 14,360 CHALRS respondents who participated in the 2011 baseline survey. The sample of this study was restricted to respondents with valid cognitive functioning scores, and there were 13,398 individuals aged 50 and above. This study aims to determine if mild cognitive impairment occurred during following years, so individuals with no follow-ups in 2013, 2015, and/or 2018 were excluded, reducing the sample to 10,242 respondents. Since there were 1,949 respondents who suffered from mild cognitive impairment at baseline, the final study sample included 8,293 individuals (Figure 2-2). Multiple imputation was conducted to impute the missing values of both dependent and independent variables using chained equations imputation, also known as Markov chain Monte Carlo algorithm. Five integrated datasets were generated, using linear regression for continuous variables and logistic regression for categorical variables. The datasets were then analyzed separately, and the estimates obtained from each dataset were combined using Rubin's rules (Rubin, 1987) to obtain one overall multiple imputation estimate.

Figure 2-2. Flowchart of the Study Sample Selection



2.2.3. Measures

2.2.3.1.Dependent Variables

Mild Cognitive Impairment: A composite battery of cognitive assessments was administered to all respondents. Two cognition measures, mental status (including Telephone Interview of Cognitive Status and figure drawing) and episodic memory (episodic memory) were used. The measures were consistent through four waves.

Telephone Interview of Cognitive Status (TICS): The TICS is a well-established scale to measure individual cognitive status as well as to monitor changes in cognitive functioning over time (Cook, Marsiske, & McCoy, 2009). Ten questions were used: today's date (day, month and year), the day of the week, the season, and serial subtraction of 7 from 100 (up to 5 times). The TICS score was calculated as the total of correct answers to these 10 questions, ranging from 0 to 10.

Figure drawing: An image of two overlapped pentagons was shown to the respondents. If they could successfully draw a similar image, then they scored 1 point. This assessed visual and spatial relationships.

Episodic memory: Episodic memory of ten words was used to test the memory domain of cognitive functioning. Ten Chinese words were read to respondents who were then asked to recall these words in any order immediately (immediate episodic memory) and 4 minutes later (delayed episodic memory). Episodic memory score was calculated as the average of the numbers of correct answers to the immediate and delayed episodic memory, and the composite measure ranged from 0 to 10.

The sum of TICS, figure drawing and episodic memory was then computed to assess the global cognitive functioning, and the score ranged from 0 to 21. Cronbach's Alpha was 0.825 across four waves. Currently there is no consensus on the meaning of mild cognitive impairment, creating challenges related to its diagnosis and definition (Fang et al., 2017). Of multiple measurements, this study used the criteria of aging-associated cognitive decline (AACD) to define mild cognitive impairment: At least 1 standard deviation (SD) below the age-appropriate norms (Fang et al., 2017; Gilles, 2003; Levy, 1994). AACD is recommended by the International Psychogeriatric Association in collaboration with World Health Organization and seeks evidence of cognitive decline within a broader range of cognitive domains: It covers basically all criteria for mild cognitive impairment and has been widely used as diagnostic criteria for mild cognitive decline by both clinicians and scholars, therefore fitting the aim of this study (Richards, Touchon, Ledesert, & Richie, 1999). Respondents were categorized into age groups, with 5-year intervals (e.g., 51-55, 56-60, 61-65……). Group means (age-appropriate norms) and SDs of the cognitive functioning scores were calculated, and respondents who scored lower than one SD from the mean were defined as mild cognitive impairment. Of 8.293 respondents, 1,898 experienced mild cognitive impairment in the follow-up waves. Similarly, using the same criteria, the episodic memory impairment and mental status impairment were defined: 4,308 and 1,540 separately.

2.2.3.2 Independent Variables

A comprehensive set of self-reported ACEs before 17 years of age were used in this study and they were family SES, nutrition, social relations, and childhood health. Family SES consisted of childhood SES and family economic hardships. Childhood SES was measured by early paternal death (yes or no), father's educational attainment and occupation as fathers were usually considered as the primary bread winners of the family. For father's education, the question was "What is the highest level of education your father completed?", and options ranged from "1. Illiterate" to "11. Graduate from post-graduate, doctoral degree." The variable was dichotomized (1=No formal education, 0=Otherwise) and preliminary analysis show that 60.79% of respondents' father had no formal education, therefore I recoded the variable into dummy to reduce further confusion caused by the multiple options. For father's occupation, the question was framed as "What was your male guardian's usual occupation when you were growing up before you were 17?" Options included "1. Farming" and "2. Non-agricultural." I recoded the variable and remained it as dummy (1=Farming, 0=Otherwise).

Considering that some respondents reported early paternal death or divorce, family comparative SES measure (i.e., experiencing economic hardship or not) was also included as a supplement to family SES. It was measured by asking, "when you were a child before 17, compared to the average family in the same community/village at that time, how was your family's financial situation?" There were five response options: "a lot better off," "somewhat better off," "same," "somewhat worse off," and "a lot worse."

The latter two answers were coded as economic hardship.

Nutrition included early maternal death (yes or no) and hunger since mothers were more likely to be the primary care provider and one of the nutrition outcome determinants. Hunger was measured by asking “When you were a child before age 17, was there ever a time when your family did not have enough to eat?” Answers included “yes” or “no.”

Social relations included childhood loneliness, poor relations with father/mother, and abuse from parents. Loneliness was measured by asking respondents, “When you were a child, how often did you feel lonely for not having friends?” Often and sometimes were coded as “yes” and not very often and never were coded as “no.” Poor relations with father/mother (yes or no) were measured by asking respondents, “How would you rate your relationship with your female/male guardian when you were growing up?” Of all the responses, fair and poor were coded as “yes” and excellent and good were coded as “no.” Abuse from father/mother (yes or no) was measured by asking, “Did your female/male guardian ever hit you?” Often and sometimes were recoded as “yes,” and rarely and never were recoded as “no.”

Poor childhood health (yes or no) was measured by asking, “Before you were 17 years old, would you say that compared to other children of the same age, you were much healthier, somewhat healthier, about average, somewhat less healthy, or much less healthy?” The latter two answers were coded as “yes” and the former three were coded as “no.”

2.2.4. Moderators

Moderators include gender (male=1) and adulthood educational attainment.

Respondents were asked “What’s the highest level of education you have now (not including adult education)?”. Responses included: 1=Illiterate, 2=Did not finish primary school, 3=Sishu/home school, 4=Elementary school, 5=Middle school, 6=High school, 7=Vocational school, 8=Two-/Three-Year College/Associate degree, 9=Four-Year College/Bachelor’s degree, 10=Master’s degree, and 11=Doctoral degree. Preliminary analysis showed that 38.87% of respondents had an educational attainment of middle school or higher, the variable recoded it into a dichotomous moderator (1=middle school or higher, 0=otherwise).

2.2.5. Covariates

Age (in years), gender (males=1), rural/urban residence (rural=1), *hukou* status (agricultural *hukou*=1), marital status (married=1), and adulthood educational attainment (middle school or higher=1) were included as covariates. Moreover, current health behaviors, including smoking, drinking, and social engagement (number of social activities that the respondents participated in: interact with friends; play ma-jong, play chess, play chess or go to community club; provide help to family, friends, or neighbors who do not live with you and who do not pay you for help; go to a sport, social, or other kind of club; take part in a community-related organization; do voluntary work or charity work; care for a sick or disabled adult who do not live with you and who do not pay you for the help; attend an educational or training course; stock investment; use the internet; other) were controlled. The baseline data for these covariates were used as non-time-varying variables.

2.2.6. Statistical Analysis

Data multiple imputation was conducted using SPSS 24.0.0.0, and data analysis was carried out using R software (version 4.0.3). Descriptive statistics of the imputed data were summarized in Table 2-1 using the baseline data and the life history data (For summary statistics of data before imputation, please refer to Appendix A). Chi-square tests and paired t-tests were employed to test the gender differences. Cox proportional hazard models, regressing ACEs on mild cognitive impairment were carried out for the whole sample, male and female subsample separately, and results were shown in Tables 2-2 and 2-3. Similarly, taking episodic memory impairment and mental status impairment as dependent variables separately, survival analysis using cox proportional hazard models were employed for the whole sample, male subsample and female subsample, and results were summarized from Table 2-4 to Table 2-7. Sensitivity analyses were also conducted, comparing the results of respondents with complete answers with results obtained after imputations. No significant differences regarding the effects of ACEs and the moderating effects of education were found.

2.3.Results

Table 2-1 summarized the sample characteristics and missingness, which ranged from 0% to 8%. Overall, there were slightly more males (53.48%) than females in the sample, and a majority of respondents had agricultural *hukou* (77.64%). Most of them were married and only 30.35% had an educational attainment of middle school or above. As for the ACEs, more respondents experienced early paternal death (12.96%) than maternal death (8.28%). Father’s education rate was more than 60%, and most respondents’ fathers had farming-related jobs (75.1%). Moreover, 3/4 of respondents experienced childhood hunger. Some respondents felt lonely (12.62%) or were in poor health (12.25%) before age 17. For family relations, 23.67% and 16.52% reported abused by mother and father separately, and about 1/5 had poor relations with parents. In terms of baseline cognitive functioning, the respondents scored an average of 12.26 out of 21, including 3.44/10 for episodic memory and 8.82/11 for mental status.

As for gender subsample comparison, more male respondents were married (90.60%) and lived in rural areas (81.53%). They were also significantly more educated than the female subsample: 38.35% reported having an educational level of middle school or above, compared with 21.15% for female respondents. Moreover, the male subsample were the main contributors of smoking and drinking behaviors, still they rated themselves as in better health conditions than the female counterparts. In terms of ACEs, the male subsample was more likely to experience early paternal death. They also came from families with lower levels of SES, considering the significant higher proportions of father's job as farming and family economic hardship. In addition to that, more males experienced childhood hunger. As for social relations and family relations, more males had childhood loneliness, and the male subsample reported higher levels of all family-related variables: abuse from mother (27.19%), abuse from father (22.50%), poor relations with father (22.66%) and poor relations with mother (18.85%). The percentages were significantly higher than the population average and the female average, indicating the poorer family relations for the male sample.

Table 2-1. Sample Characteristics (Baseline Year 2011)

	Total (*N*=8,293)	Missingness	Male (*N*=4,435)	Female (*N*=3,858)
Categorical Variables	**%**	**%**		
Male	53.48	0		
Rural	77.64	6.39	80.72	74.05***
Hukou: Agricultural	76.53	0	75.94	77.22
Married/Partnered	86.65	0	90.60	82.12***
Education:>=Middle School	30.35	0	38.35	21.15***
Smoking	44.30	0	74.63	9.41***
Drinking	34.41	0	54.68	11.12***
Poor Adulthood Health	75.67	2.50	72.72	79.08***
Early Maternal Death	8.28	0	8.66	7.85
Early Paternal Death	12.96	0	14.34	11.38***
Father: Illiteracy	60.75	7.82	61.04	60.42
Father: Farming	75.10	0	75.85	74.24*
Economic Hardship	38.59	0	39.71	37.30*
Hunger	75.29	0.66	77.46	72.78***
Loneliness	12.62	2.86	13.42	11.72*
Abuse from Mother	23.67	6.64	27.19	19.62***
Abuse from Father	16.52	5.92	22.50	9.64***
Poor Relations with Mother	17.46	5.46	18.85	15.86***
Poor Relations with Father	20.22	6.61	22.66	17.42***
Poor Childhood Physical Health	12.25	0.65	11.79	12.78*
Continuous Variables	**Mean**			
Age	62.35	0	62.60	62.07**
Social Engagement	1.24	0	1.25	1.22*
Baseline Cognition	12.26	0	12.76	11.69***
Episodic Memory	3.44	0	3.40	3.50**
Mental Status	8.82	0	9.36	8.19***

Notes: Chi-square tests and paired t-tests were carried out to compare gender group differences; $^{+}P< .10$; $*P< .05$; $**P< .01$; $***P< .001$.

However, the male subsample scored significantly higher in baseline cognition: 12.76/21 in comparison to 11.69/21 for the female subsample. For the two domains of cognitive functioning, the male subsample performed better in terms of mental status (9.36/13) while the female subsample scored higher in terms of episodic memory (3.50/10).

2.3.1. Mild Cognitive Impairment as Health Outcome

When estimating the associations between various ACEs and risk of mild cognitive impairment, to avoid co-linearity of various ACEs, correlation analysis was carried out and results were summarized in Appendix B. Most coefficients are small and close to 0. Between poor relations with mother and poor relations with father exists the largest correlation (0.508), indicating a moderate correlation. Therefore, various ACE indicators were not combined and included them separately for more detailed examination and interpretation. Cox Proportional Hazard models were applied to estimate the risk of mild cognitive impairment depending on ACEs and covariates for the whole sample, and results were summarized in Table 2-2. Coefficients have been exponentiated into hazard ratios (HRs) to facilitate forthright interpretation, and 95% confidential intervals were also provided.

In Models 1 and 2, ACEs and demographic characteristics were used as independent variables separately: nearly all demographic characteristics were significant, for instance male (HR=0.63, 95% CI:[0.56-0.72], P<0.001), adulthood educational attainment (HR=0.42, 95% CI:[0.36-0,48], P <0.001) and agricultural *Hukou* (HR=1.61, 95% CI:[1.34-1.94], P <0.001); as for ACEs, early maternal death (HR=1.14, 95% CI:[1.00-1.33], P <0.05), father's education (HR=1.37, 95% CI:[1.24-1.51], P <0.001). father's occupation as farming (HR=1.32, 95% CI:[1.17-1.48], P <0.001), childhood hunger (HR=1.20, 95% CI:[1.08-1.25], P <0.01), loneliness (HR=1.23, 95% CI:[1.08-1.39], P <0.001) and childhood health (HR=1.08, 95% CI:[1.05-1.24], P <0.05) were significantly associated with higher risks of mild cognitive impairment in later life. In Model 3, both ACEs and covariates were included simultaneously as independent variables, and results showed that father's education (HR=1.23, 95% CI:[1.11-1.35], P <0.05), and childhood hunger (HR=1.12, 95%

CI:[1.01-1.20], *P* <0.05) remained significant and the associations were in the predicted direction: father's education and childhood hunger increased the risks of mild cognitive impairment in later life by 22.5% and 20.4% separately. Moreover, in Model 3, abuse from father (HR=1.06, 95% CI:[1.04-1.23], *P* <0.05) and abuse from mother (HR=0.78, 95% CI:[0.70-0.98], *P* <0.05) were also significant. This indicated the detrimental effect of abuse from father, but protective effect of abuse from mother for respondents in terms of cognitive functioning in later life.

Adulthood educational attainment was added in Model 4 as a moderator, and the variable itself was significant across all models. Results show that in the interaction model, father's education (HR=1.20, 95% CI:[1.08-1.33], *P* <0.05), childhood loneliness (HR=1.16, 95% CI:[1.02-1.33], *P* <0.05) and abuse from parents (HR=0.98, 95% CI:[0.86-1.00], *P* <0.05 for abuse from mother and HR=1.07, 95% CI:[1.04-1.26], *P* <0.05 for abuse from father) remained significantly associated with risks of mild cognitive impairment. Meanwhile, the interaction terms between education and father's job (HR=0.62, 95% CI:[0.46-0.86], *P* <0.05), education and economic hardship (HR=0.92, 95% CI:[0.67-0.98], *P* <0.05) were significant.

Table 2-3 examined gender differences of the focal relationships, controlling for adulthood sociographic variables. For the male subsample, Model 1 included the ACEs and adulthood demographics, and results showed that only early paternal death (HR=0.76, 95% CI:[0.62-0.94], *P* <0.05), and father's education (HR=1.39, 95% CI:[1.19-1.63], *P* <0.05) were significant ACEs, impacting the risk of mild cognitive impairment in later life. Moreover, adulthood educational attainment remained as a significant protective factor (HR=0.85, 95% CI:[0.67-0.92], *P* <0.001 in Model 1). When education was added as the moderator in Model 2, the only significant interaction term was father's education and adulthood educational attainment (HR=1.06, 95%

CI:[1.02-1.36], *P* <0.05). This indicated that when the respondent had an educational attainment of middle school or above, the hazards caused by father being illiterate would actually increase by 6%.

For the female subsample, results from Model 3 showed that apart from early paternal death (HR=1.08, 95% CI:[1.02-1.29], *P* <0.05), childhood hunger (HR=1.11, 95% CI:[1.04-1.21], *P* <0.05) and loneliness (HR=1.18, 95% CI:[1.00-1.39], *P* <0.01), abuse from father (HR=1.10, 95% CI:[1.03-1.37], *P* <0.05), abuse from mother (HR=0.95, 95% CI:[0.81-0.98], *P*<0.05) was also significantly associated with risk of mild cognitive impairment. Nearly all the associations were in the expected direction: ACEs would increase the risks of mild cognitive impairment except abuse from mother. Such results were also similar to those of the whole sample: protective effects of abuse from mother, and detrimental effect of abuse from father. Lastly, in the interaction Model 4, early paternal death (HR=1.11, 95% CI:[1.07-1.33], *P* <0.05), childhood hunger (HR=1.07, 95% CI:[1.00-1.07], *P* <0.05), loneliness (HR=1.18, 95% CI:[1.00-1.40], *P* <0.05) and abuse from mother (HR=0.94, 95% CI:[0.79-0.99], *P* <0.05) were significant ACEs; moreover, there were significant interactions terms between father's education (HR=0.52, 95% CI:[0.30-0.89], *P*<0.05) economic hardship and education (HR=0.78, 95% CI:[0.41-0.85], *P* <0.05), childhood hunger and education (HR=0.73, 95% CI:[0.43-0.93], *P* <0.05). The significant interactions indicated that if the female respondent had an educational attainment of middle school or higher, the risks of mild cognitive impairment caused by father's education, family economic hardship and childhood hunger would be reduced by 48%, 22% and 27% separately.

Table 2-2. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mild Cognitive Impairment in Later Life (Whole Sample)

	Model 1		Model 2		Model 3		Model 4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	1.14*	1.00-1.33			1.04	.89-1.21	1.06	.91-1.24
Early Paternal Death	.99	.86-1.14			.93	.81-1.06	.94	.82-1.08
Father: Illiteracy	1.37***	1.24-1.51			1.23*	1.11-1.35	1.20*	1.08-1.33
Father: Farming	1.32***	1.17-1.48			1.07	.94-1.20	1.15	1.01-1.32
Economic Hardship	1.05	.95-1.15			.99	.90-1.08	1.00	.91-1.10
Hunger	1.20**	1.08-1.25			1.12*	1.01-1.20	1.09	.82-1.03
Loneliness	1.23***	1.08-1.39			1.15*	1.02-1.31	1.16*	1.02-1.33
Abuse from Mother	1.00	.88-1.13			1.00*	1.00-1.14	.98*	.86-1.00
Abuse from Father	.92	.79-1.06			1.06*	1.04-1.23	1.07*	1.04-1.26
Poor Relations with Mother	1.07	.92-1.26			1.03	.88-1.21	1.05	.89-1.24
Poor Relations with Father	1.03	.88-1.20			1.04	.89-1.21	1.03	.88-1.20
Poor Physical Health	1.08*	1.05-1.24			1.08	.95-1.24	1.10	.95-1.27
Interactions								
Early Maternal Death x Edu							.484	.31-1.23
Early Paternal Death x Edu							.993	.56-1.50
Father: Illiteracy x Edu							1.334	.91-1.63
Father: Farming x Edu							.622*	.46- .86
Economic Hardship x Edu							.813*	.67- .86
Hunger x Edu							1.055	.63-1.15
Loneliness x Edu							.979	.60-1.48
Abuse from Mother x Edu							1.204	.80-1.64
Abuse from Father x Edu							.762	.60-1.40
Poor Relations with Mother x Edu							.662	.45-1.36
Poor Relations with Father x Edu							1.268	.67-1.84
Poor Physical Health x Edu							.693	.53-1.31
Demographics								
Age			1.02***	1.02-1.03	1.02*	1.01-1.03	1.02*	1.01-1.03

Male	.63***	.56- .72	.63***	.55- .71	.63***	.55- .71
Rural	.90	.76-1.07	.89	.75-1.05	.89	.75- 1.07
Hukou: Agricultural	1.61***	1.34-1.94	1.58**	1.31-1.91	1.62**	1.34-1.96
Married/Partnered	.79***	.70- .89	.80**	.71- .90	.80**	.71 -.90
Education:>=Middle School	.42***	.36- .48	.43***	.37 -.49	.64*	.45 - .92
Smoking	1.17*	1.04-1.33	1.18**	1.04-1.34	1.18**	1.04-1.34
Drinking	.99	.89-1.11	.99	.88-1.11	.99	.89-1.11
Social Engagement	.81	.73- .90	.83	.74- .92	.82	.74- .92
Poor Adulthood Health	1.00*	1.00-1.12	1.00	.89-1.11	1.00	.90-1.11

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

Table 2-3. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mild Cognitive Impairment in Later Life (Male and Female Subsample)

	Male				Female			
	Model 1		Model 2		Model3		Model4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	1.17	.94-1.47	1.23		.93	.75-1.15	.95	.77-1.17
Early Paternal Death	.76*	.62- .94	.74		1.08*	1.02-1.29	1.11*	1.07-1.33
Father: Illiteracy	1.39*	1.19-1.63	1.43*		1.13	.99-1.28	1.1-	.97-1.25
Father: Farming	.98	.81-1.19	1.08		1.11	.95-1.30	1.18	.99-1.39
Economic Hardship	.98	.85-1.14	1.00		.99	.88-1.12	1.00	.88-1.14
Hunger	1.14	.73-1.02	1.12		1.11*	1.04-1.21	1.07*	1.04-1.07
Loneliness	1.15	.95-1.40	1.16		1.18*	1.00-1.39	1.18*	1.00-1.40
Abuse from Mother	1.10	.91-1.32	1.07		.95*	.81- .98	.94*	.79- .99
Abuse from Father	1.01	.82-1.23	1.06		1.10*	.89-1.37	1.08	.86-1.35
Poor Relations with Mother	.99	.78-1.27	1.05		1.07	.87-1.31	1.06	.86-1.30
Poor Relations with Father	1.14	.90-1.44	1.12		.95	.78-1.16	.97	.79-1.18
Poor Physical Health	1.08	.87-1.34	1.15		1.10	.93-1.31	1.09	.91-1.30
Interactions								
Early Maternal Death x Edu			.59	.27-1.32			.47	.11-1.96
Early Paternal Death x Edu			1.33	.74-2.38			.42	.13-1.36
Father: Illiteracy x Edu			1.06*	1.02-1.36			1.63	.97-2.74
Father: Farming x Edu			.68	.45-1.04			.52*	.30- .89
Economic Hardship x Edu			.95	.65-1.39			.78*	.41- .85
Hunger x Edu			.89	.60-1.32			.73*	.43 -.93
Loneliness x Edu			.91	.53-1.57			.89	.37-2.15
Abuse from Mother x Edu			1.07	.68-1.69			1.11	.58-2.12
Abuse from Father x Edu			.75	.45-1.25			1.50	.66-3.41
Poor Relations with Mother x Edu			.69	.35-1.38			1.18	.48-2.93
Poor Relations with Father x Edu			1.15	.62-2.13			.67	.25-1.80
Poor Physical Health x Edu			.65*	.34-1.22			1.27	.64-2.53

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

2.3.2. Episodic memory Impairment as Health Outcome

Similarly, survival analysis using Cox proportional hazard models were applied to estimate the risk of episodic memory impairment depending on the ACEs and covariates for the whole sample, male subsample and female subsample separately in Table 2-4 and 2-5.

In Table 2-4, for the whole sample, in Model 1, ACEs such as early maternal death (HR=1.10, 95% CI: [1.00-1.22], P<0.05), father's education (HR=1.17, 95% CI: [1.10-1.25], P <0.001), father's occupation as farming (HR=1.415, p<0.001), childhood hunger (HR=1.04, 95% CI: [1.03-1.11], P <0.05), loneliness (HR=1.15, 95% CI: [1.06-1.26], P <0.01), poor relations with mother (HR=1.05, 95% CI: [1.02-1.17], P <0.05) and poor relations with father (HR=1.09, 95% CI: [1.04-1.21], P <0.05) were significantly related to higher risks of episodic memory impairment, and the associations were in the expected detrimental direction. Demographic characteristics analysis in Model 2 indicated that adulthood educational attainment (HR=0.84, 95% CI: [0.76-0.91], P <0.001) was significant. After controlling the covariates in Model 3, gender as male (HR=0.96, 95% CI: [0.93-0.98], P <0.05) became significant, meaning that being male could reduce the risk of episodic memory impairment by 4%. Significant ACEs included father's education (HR=1.10, 95% CI: [1.03-1.17], P <0.01), childhood loneliness (HR=1.10, 95% CI: [1.01-1.20], P<0.05) and poor relations with mother (HR=1.01, 95% CI: [1.00-1.03], P <0.05). Lastly, in the interaction Model 4, childhood hunger (HR=1.07, 95% CI: [1.01-1.15], P <0.05), loneliness (HR=1.12, 95% CI: [1.02-1.23], P <0.05) and poor relations with mother (HR=1.02, 95% CI: [1.00-1.14], P <0.05) were significantly associated with higher risk of episodic memory impairment. Moreover, there were significant interactions between hunger and education (HR=0.96, 95% CI: [0.87-0.98], *P*<0.05), as well as abuse from father and education (HR=1.13, 95% CI: [1.02-1.42], *P*<0.05). This indicated that adulthood educational attainment could reduce the possible harm caused by early childhood hunger on episodic memory impairment by 4%.

Table 2-5 examined the gender differences, controlling for demographic covariates. For the male subsample, results from Model 1 showed that ACEs such as early maternal death (HR=1.05, 95% CI: [1.00-1.22], *P* <0.05), father's education (HR=1.12, 95% CI: [1.02-1.23], *P*<0.05) and poor relations with mother (HR=1.01, 95% CI: [1.00-1.17], *P* <0.05) were significantly associated with higher risks of episodic memory impairment. What's more, after including adulthood educational attainment as the moderator in Model 2, results showed that the only significant ACEs were father's education (HR=1.15, 95% CI: [1.03-1.28], *P*<0.05) and poor relations with mother (HR=1.00, 95% CI: [1.00-1.19], *P* <0.05). Significant interaction terms included abuse from father with education (HR=1.11, 95% CI: [1.02-1.46], *P* <0.05), and poor relations with father with education (HR=0.91, 95% CI: [0.64-0.98], *P* <0.05).

Results for the female subsample showed a different scenario: in Model 3, father's education (HR=1.08, 95% CI: [1.00-1.18], *P* <0.05) and loneliness (HR=1.09, 95% CI: [1.02-1.24], *P* <0.05) were significant ACEs after controlling all the covariates and the significance extended to the interaction model (Model 4), indicating the detrimental effects of father's education and childhood loneliness for females. Meanwhile, significant interaction terms between father's education (HR=1.20, 95% CI: [1.00-1.60], *P*<0.05) and adulthood educational attainment, loneliness and adulthood educational attainment (HR=0.74, 95% CI: [0.44-0.86], *P*<0.05) have been detected. This meant the significant moderating effects that education has on ACEs such as father's education and loneliness for the female subsample.

Table 2-4. Cox Proportional Hazard Model of Adverse Childhood Experiences on Episodic Memory Impairment in Later Life (Whole Sample)

	Model 1		Model 2		Model 3		Model 4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	1.10*	1.00-1.22			1.06	.95-1.17	1.06	.94-1.18
Early Paternal Death	1.02	.93-1.12			.96	.88-1.05	.95	.86-1.05
Father: Illiteracy	1.17***	1.10-1.25			1.10**	1.03-1.17	1.09	1.02-1.18
Father: Farming	1.28***	1.18-1.38			1.06	.98-1.15	1.02	.93-1.12
Economic Hardship	1.01	.95-1.07			.97	.92-1.04	.97	.91-1.05
Hunger	1.04*	1.03-1.11			1.06	.88-1.01	1.07*	1.01-1.15
Loneliness	1.15**	1.06-1.26			1.10*	1.01-1.20	1.12*	1.02-1.23
Abuse from Mother	1.01	.93-1.09			1.00	.92-1.09	.99	.90-1.09
Abuse from Father	.98	.89-1.08			1.01	.92-1.11	.99	.88-1.10
Poor Relations with Mother	1.05*	1.02-1.17			1.01*	1.00-1.13	1.02*	1.00-1.14
Poor Relations with Father	1.09*	1.04-1.21			1.09	.98-1.21	1.10	.99-1.23
Poor Physical Health	1.04	.95-1.14			1.03	.95-1.13	1.04	.94-1.15
Interactions								
Early Maternal Death x Edu							1.01	.74-1.38
Early Paternal Death x Edu							1.07	.82-1.40
Father: Illiteracy x Edu							1.02	.87-1.19
Father: Farming x Edu							1.17	.97-1.41
Economic Hardship x Edu							.98	.83-1.15
Hunger x Edu							.96*	.87- .98
Loneliness x Edu							.89	.70-1.15
Abuse from Mother x Edu							1.06	.87-1.30
Abuse from Father x Edu							1.13*	1.02-1.42
Poor Relations with Mother x Edu							1.00	.74-1.35
Poor Relations with Father x Edu							.95	.72-1.26
Poor Physical Health x Edu							.95	.75-1.22
Demographics								

Age	.99*	.99-1.00	.96**	.93- .99	.99**	.99-1.00
Male	1.01	.93-1.10	1.00*	1.00-1.09	.99*	.91-1.00
Rural	1.00	.89-1.13	.99	.88-1.12	.99	.88-1.11
Hukou: Agricultural	1.52***	1.34-1.72	1.50***	1.32-1.69	1.48***	1.31-1.68
Married/Partnered	.84***	.76- .91	.84**	.77- .92	.84**	.77- .92
Education:>=Middle School	.62***	.57- .67	.64***	.58- .69	.53***	.42- .66
Smoking	1.03	.95-1.11	1.03	.95-1.12	1.03	.95-1.12
Drinking	1.00	.93-1.07	.99	.92-1.07	.99	.93-1.07
Social Engagement	.85*	.79- .91	.85*	.80- .91	.86*	.80- .91
Poor Adulthood Health	1.07*	1.00-1.15	1.06*	.98-1.14	1.06*	1.00-1.14

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

Table 2-5. Cox Proportional Hazard Model of Adverse Childhood Experiences on Episodic Memory Impairment in Later Life (Male and Female Subsample)

	Male				Female			
	Model 1		Model 2		Model3		Model4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	1.05*	1.00 -1.22	1.04	.88-1.22	1.06	.91-1.24	1.08	.92-1.27
Early Paternal Death	.95	.84-1.08	.91	.79-1.04	.96	.84-1.10	.98	.85-1.14
Father: Illiteracy	1.12*	1.02-1.23	1.15*	1.03-1.28	1.08*	1.00-1.18	1.05*	1.02-1.16
Father: Farming	1.05	.94-1.18	.98	.86-1.13	1.07	.95-1.20	1.05	.93-1.19
Economic Hardship	.98	.90-1.07	.97	.88-1.08	.96	.88-1.06	.97	.88-1.07
Hunger	1.10	1.00-1.11	1.11	.78-1.16	.98	.88-1.08	.97	.87-1.08
Loneliness	1.12	.99-1.26	1.14	.99-1.30	1.09*	1.02-1.24	1.11*	1.03-1.26
Abuse from Mother	1.07	.95-1.19	1.08	.94-1.24	.94	.83-1.06	.92	.81-1.05
Abuse from Father	.95	.84-1.07	.92	.80-1.07	1.09	.93-1.28	1.04	.88-1.24
Poor Relations with Mother	1.01*	1.00-1.17	1.00*	1.00-1.19	1.04	.90-1.21	1.04	.89-1.22
Poor Relations with Father	1.09	.94-1.26	1.12	.95-1.32	1.08	.94-1.25	1.08	.93-1.26
Poor Physical Health	1.06	.93-1.21	1.07	.92-1.24	1.02	.90-1.16	1.03	.90-1.18
Interactions								
Early Maternal Death x Edu			1.11	.76-1.61			.73	.39-1.39
Early Paternal Death x Edu			1.27	.93-1.74			.63	.34-1.18
Father: Illiteracy x Edu			.92	.76-1.12			1.20*	1.00-1.60
Father: Farming x Edu			1.23	.96-1.57			1.10	.81-1.51
Economic Hardship x Edu			1.00	.82-1.23			.87	.63-1.20
Hunger x Edu			1.04	.83-1.30			1.09	.80-1.49
Loneliness x Edu			.91	.68-1.22			.74*	.44- .86
Abuse from Mother x Edu			.95	.74-1.22			1.28	.89-1.85
Abuse from Father x Edu			1.11*	1.02-1.46			1.48	.94-2.35
Poor Relations with Mother x Edu			1.01	.69-1.47			1.00	.60-1.67
Poor Relations with Father x Edu			.91*	.64- .98			1.03	.62-1.72
Poor Physical Health x Edu			.95	.70-1.29			.91	.60-1.38

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

2.3.3. Mental Status Impairment as Health Outcome

Tables 2-6 and 2-7 summarized the results of survival analysis using mental status impairment as dependent variables for the whole sample, male sample and female subsample separately. For the whole sample (Table 2-6), in Model 1, nearly all ACEs were significantly associated with higher risks of mental status impairment: early maternal death (HR=1.16, 95% CI:[1.02-1.38], *P*<0.05), father's education (HR=1.51, 95% CI:[1.35-1.69], *P* <0.001), father's occupation as farming (HR=1.60, 95% CI:[1.39-1.84], *P* <0.001), family economic hardship (HR=1.11, 95% CI:[1.00-1.24], *P* <0.05), childhood hunger (HR=1.15, 95% CI:[1.04-1.24], *P* <0.01), loneliness (HR=1.30, 95% CI:[1.13-1.49], *P* <0.001), poor relations with mother (HR=1.14, 95% CI:[1.02-1.37], *P* <0.05) and poor childhood health (HR=1.18, 95% CI:[1.02-1.37], *P* <0.05); and only abuse from father (HR=0.87, 95% CI:[0.74-0.92], *P* <0.05) significantly reduced the risk. In Model 2, gender as male (HR=0.49, 95% CI:[0.43-0.58], *P* <0.001) and adulthood educational attainment (HR=0.27, 95% CI:[0.22-0.33], *P* <0.001) were significantly protective, reducing the risk of mental status impairment. In Model 3, when both ACEs and adulthood demographics were included, father's education (HR=1.33, 95% CI:[1.18-1.49], *P* <0.01), childhood hunger (HR=1.08, 95% CI:[1.04-1.18], *P* <0.05), childhood loneliness (HR=1.21, 95% CI:[1.05-1.38], *P* <0.01) and poor relations with mother (HR=1.10, 95% CI:[1.08-1.19], *P* <0.05) were significant ACEs, and these variables remained significant in the interaction Model 4. Moreover, significant interactions included: hunger and education (HR=0.58, 95% CI:[0.38-0.88], P<0.05), poor relations with father with education (HR=1.08, 95% CI:[1.05-2.33], *P* <0.05) and poor childhood health with education (HR=0.86, 95% CI:[0.46-0.91], *P* <0.05).

In Table 2-7, the male subsample had slightly different results with those of the whole sample: in Model 1, father's education (HR=1.66, 95% CI:[1.35-2.05], *P* <0.01), childhood loneliness (HR=1.36, 95% CI:[1.08-1.72], *P* <0.05), poor relations with mother (HR=1.00, 95% CI: [1.00-1.37], *P*<0.05) and poor childhood health (HR=1.26, 95% CI:[1.07-1.62], *P* <0.05) were significantly related to higher risks of mental status impairment. In addition, abuse from mother (HR=0.93, 95% CI:[0.73-0.98], *P* <0.05) was a protective factor. The same set of ACEs were also significant in the interaction model: father's education (HR=1.68, 95% CI:[1.33-2.12], *P*<0.05), childhood loneliness (HR=1.39, 95% CI:[1.09-1.78], *P* <0.05), poor relations with mother (HR=1.00, 95% CI:[1.00-1.39], *P* <0.05), poor childhood health (HR=1.28, 95% CI:[1.02-1.68], *P* <0.05) and abuse from mother (HR=0.99, 95% CI:[0.78-1.00], *P* <0.05). The only significant interaction was between poor relations with mother and adulthood educational attainment (HR=0.87, 95% CI:[0.35-0.98], *P* <0.05).

Finally, for the female subsample, in Model 3, significant ACEs were different from those of the male subsample: father's education (HR=1.21, 95% CI:[1.05-1.38], *P* <0.001), father's job (HR=1.23, 95% CI:[1.03-1.47], *P* <0.001), childhood hunger (HR=1.10, 95% CI:[1.02-1.04], *P* <0.05), loneliness (HR=1.14, 95% CI:[1.05-1.35], *P* <0.01), and abuse from father (HR=1.26, 95% CI:[1.01-1.56], *P* <0.05), all in the expected detrimental direction. The same set of ACEs remained significant in the interaction Model 4, impacting the risk of mental status impairment directly. Also, the interaction terms between childhood hunger and education (HR=0.33, 95% CI:[0.16-0.67], *P* <0.05), abuse from mother and education (HR=2.22, 95% CI:[1.04-4.71], *P* <0.05) were found to be significant, indicating the moderating effect of education for the female subsample.

Table 2-6. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mental Status Impairment in Later Life (Whole Sample)

	Model 1		Model 2		Model 3		Model 4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	1.16*	1.02-1.38			1.05	.89-1.25	1.07	.90-1.27
Early Paternal Death	1.00	.86-1.17			.95	.82-1.11	.96	.83-1.13
Father: Illiteracy	1.51***	1.35-1.69			1.33**	1.18-1.49	1.30***	1.16-1.47
Father: Farming	1.60***	1.39-1.84			1.21	1.04-1.40	1.23**	1.05-1.43
Economic Hardship	1.11*	1.00-1.24			1.04	.93-1.15	1.04	.93-1.16
Hunger	1.15**	1.04-1.24			1.08*	1.04-1.18	1.03*	1.02-1.10
Loneliness	1.30***	1.13-1.49			1.21**	1.05-1.38	1.22**	1.05-1.40
Abuse from Mother	.96	.84-1.11			.96	.83-1.10	.93	.80-1.08
Abuse from Father	.87*	.74- .92			1.10	.93-1.30	1.13	.95-1.35
Poor Relations with Mother	1.14*	1.02-1.37			1.10*	1.08-1.30	1.11*	1.03-1.33
Poor Relations with Father	.98	.82-1.17			1.01	.85-1.19	.99	.84-1.19
Poor Physical Health	1.18*	1.02-1.37			1.17	1.01-1.35	1.17*	1.01-1.36
Interactions								
Early Maternal Death x Edu							.44	.13-1.42
Early Paternal Death x Edu							.67	.29-1.56
Father: Illiteracy x Edu							1.33	.87-1.04
Father: Farming x Edu							.90	.56-1.45
Economic Hardship x Edu							.90	.57-1.43
Hunger x Edu							.58*	.38- .88
Loneliness x Edu							.86	.43-1.68
Abuse from Mother x Edu							1.36	.81-2.28
Abuse from Father x Edu							.66	.34-1.27
Poor Relations with Mother x Edu							.77	.34-1.71
Poor Relations with Father x Edu							1.08*	1.05-2.33
Poor Physical Health x Edu							.86*	.46- .91
Demographics								
Age			1.02**	1.01-1.3	1.02*	1.01-1.03	1.02***	1.01-1.02

Male	.49***	.43- .58	.49***	.42- .56	.48***	.41- .56
Rural	.95	.77-1.16	.90	.74-1.10	.91	.74-1.11
Hukou: Agricultural	2.09***	1.65-2.65	2.02**	1.60-2.56	2.03***	1.61-2.58
Married/Partnered	.81***	.71- .93	.82**	.71- .94	.82**	.71- .94
Education:>=Middle School	.27***	.22- .33	.28***	.23- .35	.43**	.25- .73
Smoking	1.03	.89-1.19	1.04*	1.02-1.20	1.03*	1.00-1.20
Drinking	.99	.87-1.14	.99	.86-1.13	.99	.87-1.13
Social Engagement	.72*	.62- .82	.73*	.63- .84	.73***	.63- .84
Poor Adulthood Health	1.07*	.95-1.22	1.06	.93-1.20	1.06	.93-1.20

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

Table 2-7. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mental Status Impairment in Later Life (Male and Female Subsample)

	Male				Female			
	Model 1		Model 2		Model3		Model4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	1.00	.75-1.34	1.01	.75-1.36	1.07	.87-1.33	1.10	.89-1.36
Early Paternal Death	.82	.64-1.07	.83	.63-1.09	1.02	.85-1.24	1.04	.86-1.26
Father: Illiteracy	1.66**	1.35-2.05	1.68*	1.33-2.12	1.21*	1.05-1.38	1.18*	1.03-1.36
Father: Farming	1.17	.90-1.52	1.18	.89-1.58	1.23*	1.03-1.47	1.24	1.04-1.49
Economic Hardship	1.01	.84-1.21	1.05	.87-1.28	1.05	.92-1.20	1.05	.91-1.18
Hunger	1.03	.78-1.22	1.03	.80-1.32	1.10*	1.02-1.04	1.05*	1.02-1.10
Loneliness	1.36*	1.08-1.72	1.39*	1.09-1.78	1.14*	1.05-1.35	1.14*	1.05-1.36
Abuse from Mother	.93*	.73- .98	.99*	.78-1.00	.92	.77-1.09	.89	.74-1.06
Abuse from Father	1.03	.89-1.21	1.02	.75-1.31	1.26*	1.01-1.56	1.26*	1.01-1.58
Poor Relations with Mother	1.00*	1.00-1.37	1.00*	1.00-1.39	1.13	.92-1.40	1.15	.93-1.43
Poor Relations with Father	1.19	.89-1.61	1.21	.89-1.65	.92	.75-1.14	.92	.74-1.14
Poor Physical Health	1.26*	1.07-1.62	1.28*	1.02-1.68	1.14	.95-1.36	1.13	.95-1.36
Interactions								
Early Maternal Death x Edu			.82	.24-2.71			.00	00- .00
Early Paternal Death x Edu			1.01	.38-2.69			.26	.03-1.93
Father: Illiteracy x Edu			.96	.55-1/70			1.71	.86-3.41
Father: Farming x Edu			.93	.47-1.80			.89	.43-1.84
Economic Hardship x Edu			.68	.37-1.24			1.54	.73-3.23
Hunger x Edu			.70	.39-1.25			.33*	.16- .67
Loneliness x Edu			.75	.33-1.74			.76	.22-2.57
Abuse from Mother x Edu			.97	.47-1.98			2.22*	1.04-4.71
Abuse from Father x Edu			.59	.25-1.39			1.18	.42-3.31
Poor Relations with Mother x Edu			.87*	.35- .98			.59	.14-2.15
Poor Relations with Father x Edu			1.02	.31-2.38			.87	.23-3.40
Poor Physical Health x Edu			.74	.31-1.82			.97	.39-2.40

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +P< .10; *P< .05; **P< .01; ***P< .001.

2.4.Discussion

2.4.1. The Whole Sample --- Mild Cognitive Impairment, Episodic Memory Impairment and Mental Status Impairment

Focusing on older adults in China, this study examined the associations between ACEs, adulthood educational attainment and mild cognitive impairment in later life and explored the gender differences. Overall, findings revealed that, for the whole sample, childhood SES (represented by father's education and father's occupation as farming) was significantly associated with increased risks of mild cognitive impairment, and the effect of father's occupation as farming was attenuated by adulthood socio-demographic characteristics. This is in accordance with the previous literature, re-confirming the long-lasting effects of childhood SES on individual cognitive change in later life (Barnes & Yaffe, 2011; Bradley & Corwyn, 2002).

Other than that, childhood hunger was also found to significantly increase the risks of mild cognitive impairment in later life: childhood nutrition deprivation has clear negative consequences for children's cognitive development (Zhang, Gu, & Hayward, 2008). Three mechanisms have been put forward to explain the associations: the critical period hypothesis posited that undernutrition in early life would impair brain development and lead to less efficient brain function because of "less myelin, less branching of dendrites, and less developed connectivity patterns" (Moceri, Kukull, Emanuel, van Belle, & Larson, 2000). The negative effects of the impaired brain development would aggravate by the aging process, thus nutritional deprivation during developmentally important periods (in utero and early childhood) may have long-term negative effects on cognitive function. The second mechanism predicted that nutritional disadvantages in early-life indirectly influenced late-life cognition via social conditions and health problems. For instance, researchers have argued that education in early-life promoted brain growth in the formative years and enabled the brain network to operate more efficiently, thus providing protection against cognitive decline in later life (Frisch, McClendon, Smyth, Lerner, Friedland, & Larsen, 2007; Kaplan, Turrell, Lynch, Everson, Helkala, & Salonen, 2001). Malnourished children might lack the energy and motor skills essential to thrive in school and thus completed fewer years of schooling, which in turn affected late-life cognition (Mendez & Adair, 1999). Lastly, the research linking early-life nutritional deficiencies with cardiovascular and metabolic conditions pointed to possible physical disease pathways: both conditions were associated with cognitive impairment, suggesting that early-life nutrition may set in motion a cascade of physical health problems resulting in cognitive impairment (National Research Council, 2000).

Another important childhood risk factor was interpersonal relationships, which included relationships with parents and childhood loneliness, highlighting the importance of peer and family relationships. Childhood interactions with friends and others might also help to promote cognitive development, and such social skills laid foundations for adulthood social relationships, therefore possibly preventing social isolation and promoting cognitive maintenance in later life as well (Burr, Han, & Peng, 2020). Lack of social interactions and feelings of loneliness might lead to social disconnectedness, therefore decreasing levels of cognitive functioning in later life (Lempinen, Junttila, & Sourander, 2018).

Similarly, close family relationships were found to be associated with better physical health throughout the life span (Miller, Chen, & Parker, 2011). It is speculated that close family relationships could elicit cognitive, emotional and behavioral responses in children, which are beneficial to the cognitive development through adulthood and later life (Cummings & Davies, 2002). Meanwhile, positive childhood family relationships might also help to buffer the detrimental effects of other ACEs, therefore indirectly benefiting the cognitive maintenance (Chen, Brody, & Miller, 2017). This might explain the significance of abuse from father in increasing risks of mild cognitive impairment. These findings fit the life course perspective and suggested that ACEs were critical to long-term health development. However, abuse from mother was found to be significantly reducing the risk of mild cognitive impairment: This is out of expectation and does not conform to current literature, that children exposed to parental harsh discipline (e.g., corporal punishment and physical abuse) were at a higher risk for a number of negative developmental outcomes, both physically and mentally (Xing, Wang, Zhang, He, & Zhang, 2011; Xing & Wang, 2013). This finding suggested that compared with abuse from father, mothers often discipline their children by minor warnings and punishments, therefore guiding them about what is right and what is wrong. The conception of Chinese parents' use of discipline is sometimes indicative of caring and loving (Wang & Liu, 2017), therefore in the context of China, the discipline from mothers might be regarded as cognitive-stimulating and in effect protective of future cognitive impairment risks. Moreover, abuse from mother, or discipline from mother signified attachment of and communication between mother-child, and it has been found that associations between memories of caregiver interactions and health persisted over time and into late life (Chopik & Edelstein, 2020). Such memories could trigger cognitive and emotional responses to interpersonal situations, which affect stress response systems and health behaviors, thus affecting downstream health outcomes (Collins, 1996; Pietromonaco, DeBuse, & Powers, 2013).

For adulthood characteristics, educational attainment significantly decreased the risk of mild cognitive impairment directly, and although its interactions with father's job and with family economic hardship were significant, these ACEs themselves did not have any significant associations with the risk of mild cognitive impairment. In this sense, the influences of ACEs and adulthood educational attainment had on the health outcome were direct and separate: Education in adulthood did not moderate any of the detrimental effects of ACEs.

Then this study turned to the two domains of cognitive functioning: episodic memory and mental status. For the whole sample, only loneliness and poor relations with mother were significantly related to episodic memory impairment. This is in accordance with the previous discussion, that childhood personal relationships had long-lasting influences on health outcome in later, including family relationships and peer relationships. Moreover, the interaction model outcome showed that childhood hunger was significantly moderated by adulthood educational attainment: education has been found to be a key mechanism through which social class is reproduced across generations, providing economic, social and cultural capital (Bourdieu & Wacquant, 1992). Education acted as a flexible and powerful resource that allowed the under-nutritious individuals to avoid health risks and adopt healthy lifestyles (Link, Phelan, Miech, & Westin, 2008). For instance, education provided favorable economic and material conditions as well as greater psychosocial resources, which can in turn promote the brain development in adulthood, therefore enhancing the individual memories.

However, no such significant interactions were detected for the mental health domain of cognitive functioning. For mental health impairment, similar to the results of mild cognitive impairment, the ACEs and adulthood educational attainment impacted the health outcome directly and separately: childhood adversities increased the risks, while adulthood educational attainment had protective effects.

2.4.2. The Male Subsample --- Mild Cognitive Impairment, Episodic Memory Impairment and Mental Status Impairment

This study also revealed gender differences. For sample characteristics, the male subsample experienced higher levels of ACEs but ended up with better performance in cognitive functioning tests at baseline. They scored higher in mental health and did not perform as good in episodic memory domain. This echoed with previous literature on gender differences in specific cognitive activities: Findings revealed that males often outperformed females on visuospatial abilities and females outperformed males in most other tests of cognition, for instance memory, language and attention (Caskie, Schaie, & Willis, 1999; Gerstorf, Ram, Hoppmann, Willis, & Schaie, 2011). Findings from the whole sample analysis showed that being male reduced the risk of mild cognitive impairment by more than 40%, compared to their female counterpart. This is a little different from existing studies, which held that there were steeper rates of decline for males on cognitive functioning in later life, while females exhibited greater resilience to age-related cognitive decline (McCarrey, An, Kitner-Triolo, Ferrucci, & Resnick. 2017). Findings from this study indicated that when controlling both childhood and adulthood characteristics, males enjoyed the overwhelming advantage in better cognitive functioning performance in later life.

Cox proportional hazard model results showed that for the male subsample, father's education was the only significant ACE for mild cognitive impairment in later life. Adulthood educational attainment was also especially significant, reducing more than 60% of the risk. However, the interaction between father's education and individual adulthood education greatly increased the risk: the hazard ratio increased by one-fold when the respondent had an educational attainment of middle school or above. This is new and no related studies have provided possible explanations or mechanisms on why education would aggravate the detrimental effects of father's education.

When this study tried to separate cognitive function into episodic memory and mental status, the male subsample had different outcomes: For episodic memory, family relations, represented by early maternal death and poor relations with mother, were especially significantly related to higher risks of episodic memory impairment. The two ACEs were all mother-related, and no father-related variables were significant. This indicated that the loss of mother rather than father in early life was detrimental to cognitive health (Norton et al., 2011). One possible explanation is that in traditional Chinese society, mothers were more likely than fathers to be the primary care providers and therefore had stronger affective, cognitive and behavioral connections to their offspring (Fan, 2003). Therefore, among a population with limited opportunities for formal education, the absence of mother caring in early life might disrupt the cognitive development of the children, which further might lead to cognitive impairment in later life. Moreover, the fact that early maternal death was only significant for the male subsample but not for the female subsample was different from findings of Takeuchi and colleagues (2003), that losing the same-sex parents was associated with worse health. It was speculated that females were more resilient than their male counterparts since females in traditional Chinese society tended to experience more disadvantages in many aspects of life (Liu, Fu, Roberto, & Salva, 2019). Additionally, Samplin and colleagues (2013) also found that the brains of healthy males were more vulnerable to childhood adversities than healthy females, and this might further help explain why mother-related variables were significant for males but not for females.

Lastly, for mental status, the male subsample scored higher at baseline and gender being male indeed offered advantage in prevention of possible impairment. Family SES, represented by father's education, childhood loneliness, and poor relations with mother were significantly associated with higher risks of mental health impairment. Additionally poor childhood health was also impacting late-life cognition: studies have found that retrospective reports of better childhood health was associated with improved cognitive functioning in old age (Luo & Waite, 2005; Yi, Gu, & Land, 2007). Childhood diseases might also have long-term negative mental health outcomes, either via direct effects of pathogens or indirect effects of inflammatory response (Khandaker, Zimbron, Dalman, Lewis, & Jones, 2012).

Another set of noteworthy variables are mother-related. Abuse from mother was protective and actually reduced the risk of mental health impairment in later life, while at the same time poor relations with mother increased the risk. Biosocial theory of sex differences might provide some rationales for this. According to this theory, parents are expected to use different control strategies with boys than with girls: parental control of girls would be characterized by kindness, consideration of others' perspective and empathy, whereas parental control of boys would be characterized by power, assertive ness, and dominance (Wood & Eagly, 2002). What seemed to be "abuse" from the child's point of view might be the appropriate parental control behaviors to keep the children in accordance with the gender roles defined in their society (Wood & Eagly, 2012). That's why "abuse from mother" in childhood might to a certain extend benefit cognitive development.

At the same time, poor relations with mother might indicate no control and neglect, and this and would lead to increased risks of impaired mental health, confirming the harm of poor family relations discussed above. Moreover, its interaction with adulthood educational attainment indicated that education could and only could moderate the detrimental effects of poor relations with mother for the male subsample. Other ACEs, including father's education, childhood loneliness and poor childhood health impacted late-life mental health directly.

2.4.3. The Female Subsample --- Mild Cognitive Impairment, Episodic Memory Impairment and Mental Status Impairment

As has discussed above, the female subsample suffered comparatively less from ACEs but ended up with lower scores of baseline cognition. Results of demographic characteristics analysis also show that they were less likely to have drinking or smoking behaviors but generally rated themselves as in lower levels of health conditions. The possible roles that adulthood conditions played in this process should be taken into consideration, and findings of this study confirmed such roles.

For mild cognitive impairment, results showed that multiple ACEs were related to higher risks in later life for females: early paternal death, hunger, loneliness, and abuse from both parents. Compared with the male subsample, who was more susceptible to early maternal death, the female subsample was influenced more by the loss of father in childhood. Other than the caring and love, losing father might also indicated the loss of family income source and lower levels of family SES, which has been studied as one of the main ACEs contributing to cognitive decline in later life (Greenfield & Moorman, 2019). What is worthy of noticing is the significant influence of abuse from parents: abuse from mother was protective while abuse from father was detrimental to mild cognitive impairment. One possible mechanism is also through biosocial theory, that mothers are more likely to be the primary caregivers of young children, females are sometimes overrepresented in educational and nurturing occupations, and males are overrepresented in occupations that are associated with power, physical strength, status, and agentic personality characteristics (Huerta et al., 2013). From the perspective of children, there might be different criteria and understandings for abuse from mother and abuse from father and sometimes they might mistake guidance and discipline from mother as abuse: since they were used to the loving and caring image of mothers, even a little bit strictness and solemn might seem indifferent (Endendijk, Groeneveld, Bakermans-Kranenburg, & Mesman, 2016). As for why this only worked for the female subsample, one guess is that females were often less favored in the traditional Chines family, and therefore they were more sensitive to negative stimuli and interpreted more of their parents (Deng, Chang, Yang, Huo, & Zhou, 2016), making them more susceptible to the actions and words from parents.

The significant interaction between adulthood educational attainment and childhood hunger confirmed the resource substitution theory for the females (Ross & Mirowsky, 2006) – not only limited to lowering the risk of mild cognitive impairment; In the episodic memory subsection, adulthood educational attainment significantly moderated the detrimental effects of father's education and childhood lonely, while in the mental health subsection, the influences of childhood hunger was also balanced out by education. Only for the female sample, adulthood educational attainment worked as an effective compensatory resource. The theory contended that socioeconomic resources have stronger effects on adulthood health for individuals from disadvantaged backgrounds because resources in adulthood substitute or compensate for a paucity of health-related sources earlier in life. In this sense, the female subsample in this study indeed came from disadvantaged backgrounds and tended to have lower levels of. subjective sense of personal control, and therefore they benefited more from education (Bauldry, 2014). Furthermore, females who obtained higher education credentials might be especially resilient (Schafer, Wilkinson, & Ferraro, 2013). All these would result in stronger associations between early life experiences, education, and health for the female subsample. It is worthy of noticing that the females were less educated than the males --- only 21.15% of them had an educational level of middle school or higher, compared with 38.35% in males. Still, they benefited the most from the chances of education.

2.5.Conclusion

Using a set of nationally representative and longitudinal data in China, this study investigated the long-term of ACEs on mild cognitive impairment among older adults. From a life course perspective, the findings revealed that childhood adversities such as family SES, family relations and peer relations had long-lasting influences on health outcomes in later life. Analysis of cognitive functioning domains showed that both episodic memory and mental status could benefit from adulthood educational attainment directly or indirectly. Moreover, under the resource substitution framework, this study found that adulthood educational attainment worked as an effective moderator in buffering the detrimental health effects of ACEs, especially for the females.

2.5.1. Policy Implications

Findings of this study were informative for policy interventions aiming to promote the health and well-being of children and adolescents with adverse experiences. Policy makers in China should look into providing sufficient care and support to children who grew up in poverty, experienced social isolations, or did not grow up with a parent, especially a mother to mitigate possible long-term detrimental health impacts in later life. More governmental and societal attention and resources should be devoted to improving the communities that the kids and young adults live, learn and work, as these investments can make a long-term positive effect on their cognitive health in later life. Moreover, the especially significant moderation of adulthood educational attainment for females stressed the importance of universal education: policies and interventions that target the less-educated females might not only improve the health and survival of tens of thousands of children, but ultimately may benefit the whole society many decades later in terms of reducing the burden of cognitive impairment of older adults.

2.5.2. Study Limitations

This study has its limitations that need to be addressed. First, the multiple imputation was based on the assumption that the data missingness was random, and this study was not able to verify this assumption. Second, markers of ACEs were collected by the self-reporting of respondents, therefore this might involve recall bias and result in an underestimation of the association between ACEs and mild cognitive impairment in later life. Third, some protective factors such as levels of resilience and self-management that were related to cognition were not included, because these variables were not available in CHARLS. And finally, some biological risk factors that were related to cognitive health were missing for analysis in the CHARLS data.

2.5.3. Contributions

Despite these limitations, this study makes contributions to the current discussion about childhood conditions and late-life cognition by investing this association with a population-based, random, and longitudinal survey in China and encompassed a comparatively large sample size. This enabled ACEs to be assessed using a wide range of measures and cognitive functioning to be analyzed based on the two subsections --- this is one of the first studies that used multiple ACEs and multiple cognitive functioning domains that studied older adults in China. By investigating the long-term impact of ACEs on mild cognitive impairment, this study has enriched the literature on how health issues in advanced age might have origins rooted in early life. The gender difference analysis also allowed for the test of resource substitution theory. And lastly, by utilizing the nationally representative data, the results had great validity and were generalizable to a wider population, bringing great policy implications and values.

CHAPTER 3: Adverse Childhood Experiences, Adulthood Educational Attainment and Mild Cognitive Impairment in Later Life: Exploring Gender Differences Using HRS

3.1. Introduction

Understanding the psychosocial processes that contribute to cognitive functioning in later life is both an international and U.S. national priority for health and aging research. The importance of research in this area is predicated on the value of preventing the onset and progress of Alzheimer's disease and related dementias (ADRD) for individuals, families, and societies (Greenfield, Moorman, & Rieger, 2021). A growing body of social and epidemiological research has focused on the role of adverse childhood experiences (ACEs) in influencing cognitive functioning in later life, especially cognitive impairment, since it is often related to declines in quality of life among older adults. In addition, cognitive impairment has consequences for families, imposing caregiving burdens on family members and generate high health care utilization costs for society (Gallagher et al., 2011).

As has introduced, cognitive impairment is the risk factor for onset of dementia, including Alzheimer's disease. The U.S. Centers for Disease Control and Prevention (2007) reported that the number of individuals diagnosed with Alzheimer's disease has doubled in the United States since the 1980s, and approximately 16 million adults would be afflicted by year 2050. In addition, research shows that older adults whose cognitive function declines have a higher mortality rate than those with normal cognition (Bassuk, Wypij, & Berkman, 2000; Schupf et al., 2005). In recent years the number of studies examining cognition among older adults from a life course perspective is increasing (Brown, Wilmoth, & London, 2014; Gonzalez, Tarraf, Bowen, Johnson-Jennings, & Fisher, 2013; Haan, Zeki Al-Hazzouri, & Aiello, 2011; Horvat et al., 2014; Tuong, Couture, Alvarado, & Zunzunegui, 2008; Singh-Manoux, Richards, & Marmot, 2005).

Multiple studies concerning the role of ACEs in influencing late life cognitive functioning among older adults in the United States have been carried out (Brown, 2010; Brown, Wilmoth, & London, 2014; Everson-Rose, de Leon, Bienlas, Wilson, & Evans, 2003; Fors, Lennartsson, & Lundberg, 2009; Kaplan et al., 2001; Luo & Waite, 2005; Singh-Manoux, Richards, & Marmot, 2005). Most studies rely on cross-sectional or two-wave longitudinal designs (Fors, Lennartsson, & Lundberg, 2009; Kaplan et al., 2001; Luo & Waite, 2005; Singh-Manoux, Richards, & Marmot, 2005). The most commonly studied is childhood SES, represented by mother's and father's educational attainment, father's occupation, and financial well-being in childhood, and these elements are often evaluated retrospectively. For instance, it has been found that parents' education is a key factor in influencing children's future education and occupation, since well-educated parents are more likely to construct and provide stable living conditions, both economically and socially (Crosnoe & Elder, 2014). These findings supported that early childhood events could have direct long-term relations with health outcomes in later life, independent of other experiences and exposure to risk factors during adulthood (Ben-Shlomo & Kuh, 2002; Kaplan et al., 2001; Kuh, Ben-Shlomo, Lynch, Hallqvist, & Power, 2003). According to Cohen, Janicki-Deverts, Chen, and Matthews (2010), earlier risk exposures tend to have more powerful impacts on health outcomes than risk factors at other stages of the life course. This may be because early childhood represents a "sensitive period" associated with development and health in later life.

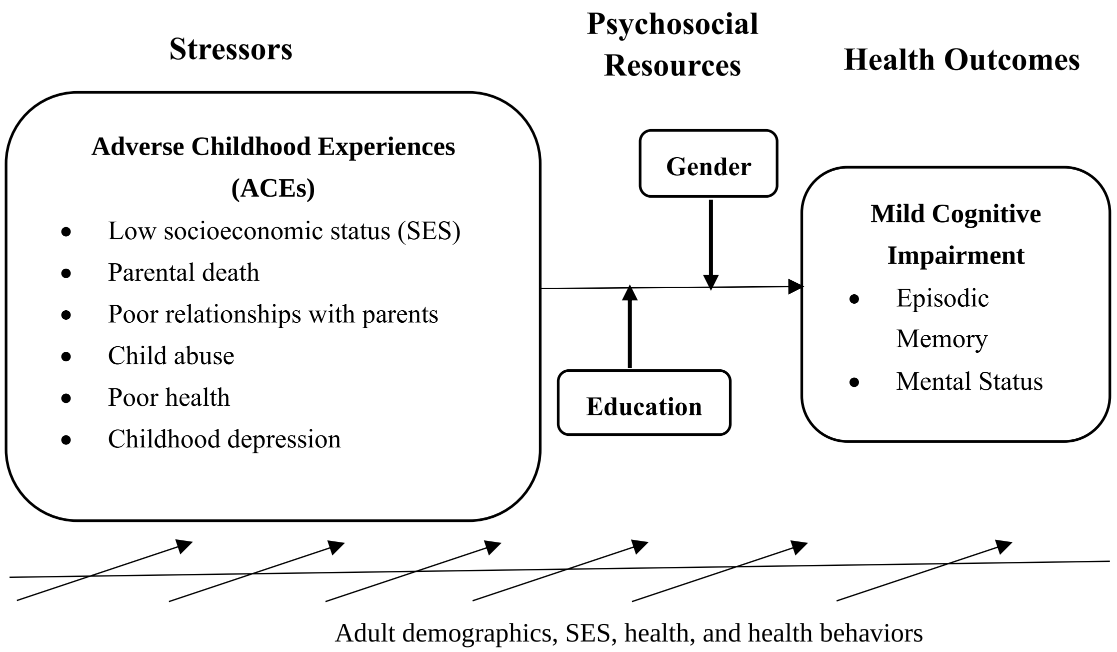
Although many studies have revealed the direct relationship between childhood conditions, adulthood education and health outcomes in later life, there are other studies supporting indirect relationships (Luo & Waite, 2005; Singh-Manoux, Richards, & Marmot, 2005). One way that education is expected to help reduce the decline in cognitive functioning in later life is through cognitive reserve mechanisms: Education has an impact on the brain structure and function, which in turn is related to reserve cognitive resources (Richards & Deary, 2005). Individuals with more cognitive reserve are better able to deal with possible brain damage. Therefore, well-educated individuals tend to experience less cognitive decline and lower risks of cognitive impairment because high educational attainment is a protective factor against neuropathology, reducing the possible detrimental effects of ACEs. Therefore, one hypothesis for this study is that adulthood educational attainment would moderate the associations between ACEs and late life cognition, such that the effects caused by ACEs might be moderated by higher levels of education in young adulthood and middle age.

Meanwhile, cognitive functioning, exposure to and health consequences of ACEs as well as adulthood educational attainment may differ by important demographic factors. Cognitive gender differences have been reported widely, typically with a life-long advantage for males in tasks assessing visuospatial and mathematical abilities (Halpern et al., 2007; Voyer, Voyer, & Bryden, 1995), whereas females were often found to outperform males in tasks assessing episodic memory and reading literacy (Herlitz, Nilsson, & Backman, 1997; Herlitz & Rehnman, 2008). Meanwhile, in terms of ACEs, studies have revealed that more than half of U.S. males and females have experienced some type of ACE. More females than males have experienced three or more types of ACE, and more females experienced sexual and physical abuse (Dong, Anda, Dube, Giles, & Felitti, 2003; Evans, Grella, & Upchurch, 2017). It is argued that

ACEs could generate negative self-emotions (e.g. guilt, shame, self-devaluation) that were most externalized as aggressive and impulsive behaviors among boys, while in contrast such experiences were more likely to be internalized as anxiety, depression and social withdrawal among girls, and lead to further destruction of cognitive functioning (Leadbeater, Kuperminc, & Blatt, 1999). Moreover, it has been found that increasing educational attainment could be the key to reducing cognitive health disparities, and education has different beneficial effect on health and survival for males and females (Ross, Master, & Hummer, 2013). Few studies have explored the early life factors that could explain the gender differences in cognitive functioning, and this study tend to fill in the gap. Moreover, according to the resource substitution theory, education could help females overcome their health disadvantage and possibly raising their health to the same high level as males, reducing the gender disparity. However, it could also be that education makes less of a difference to females since they were disadvantaged in basically every aspect (Ross & Mirowsky, 2011). Therefore, the added value of this study is to explore the gender differences in the possible moderating role of adulthood educational attainment on cognitive functioning.

Taken together, this study aimed to extend U.S. population-based research on ACEs as a predictor of later life cognitive functioning by using data from the Health and Retirement Study (HRS) --- a cohort sample that has not been utilized widely for the study of cognitive functioning. Based on this, the current study aims to make three major contributions to the understanding of the association between ACEs and cognitive functioning in later life. First, this study is among the first to investigate the longitudinal associations between ACEs, adulthood educational attainment, and mild cognitive impairment, the stage between expected normal cognitive decline and serious impairment as dementia. Second, The HRS includes prospective measures of episodic memory and mental status for cognitive functioning as well as multiple questions concerning childhood conditions, therefore this study could examine both ACEs and cognitive functioning as multidimensional constructs. And third, this study aims to explore the possible gender differences in the focal relationships, adding to the body of literature on subgroup variations. The conceptual framework of this study is presented in Figure 3-1.

Figure 3-1. Conceptual Framework Linking Various Aspects of Adverse Childhood Experiences (ACEs) with Mild Cognitive Impairment in Later Life



3.2. Methods

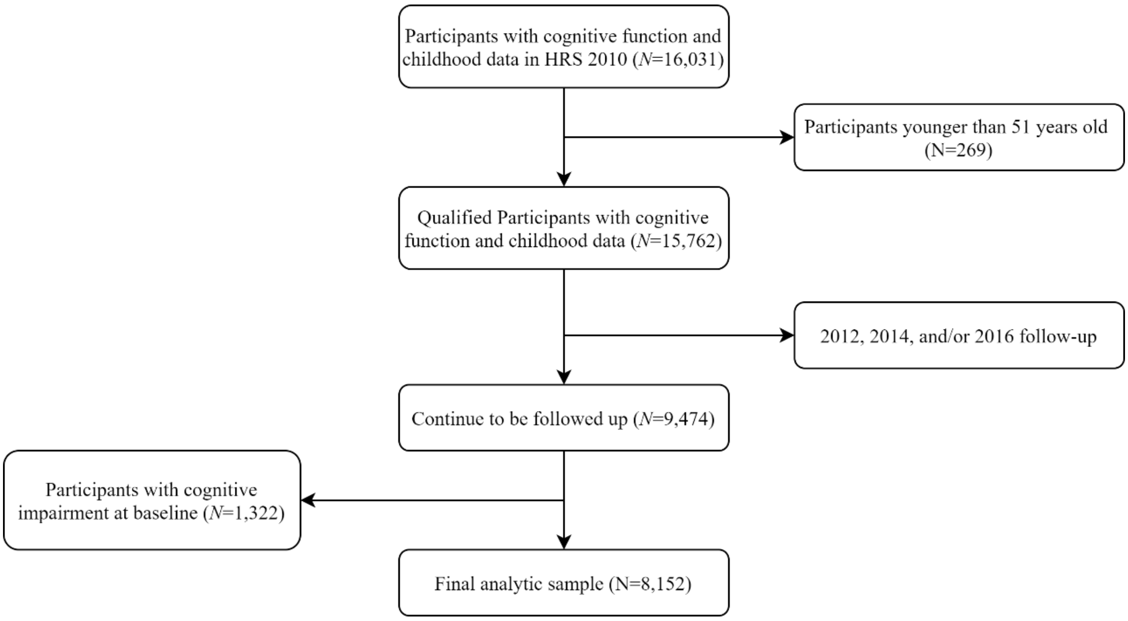
3.2.1. Data

Data for this study were taken from the Health and Retirement Study, a nationally representative survey of persons aged 51 and above, the study was conducted by the University of Michigan and funded by the National Institute on Aging. The HRS is a biennial longitudinal panel study of community-dwelling adults in the United States, with oversamples of African Americans and Hispanics (Servais, 2010). The study provided detailed information on demographic characteristics, income and wealth, work, pension plans, health insurance, disability, physical health and functioning, cognition, and health care expenditures. Additional information about the study could be found at http://hrsonline.isr.umich.edu. The childhood questionnaire items were included in the HRS survey since 1998. To foster comparison with CHALRS, this study used the 2010-2016 waves from the core HRS data. Data on demographic characteristics and health conditions were taken from special HRS data constructed and distributed by the RAND Corporation, and data on childhood conditions come from the Cross-wave childhood health and family aggregated data section of HRS.

3.2.2. Study Sample

There were 16,031 HRS respondents who had both cognitive functioning and childhood data in 2010 (baseline). The study sample was restricted to respondents living in the community, and there were 15,762 individuals aged 51 and above. Moreover, since this study aims to determine if the respondent became cognitively impaired in follow-up studies, individuals with no follow-ups in 2012, 2014 and 2016 were excluded, reducing the sample to 9,474 respondents. Respondents who were suffering from mild cognitive impairment at the baseline were also deleted, and the final study sample included 8,152 respondents at baseline (Figure 3-2). For missing data on demographic characteristics and individual health behaviors, multiple imputations were carried out using chained equations imputation, also known as Markov chain Monte Carlo algorithm. Five integrated datasets were generated, using linear regression for continuous variables and logistic regression for categorical variables. The datasets were then analyzed separately, and the estimates obtained from each dataset were combined using Rubin's rules (Rubin, 1987) to obtain one overall multiple imputation estimate.

Figure 3-2. Flowchart of the Study Sample Selection



3.2.3. Measures

3.2.3.1. Dependent Variables

To measure cognitive functioning, a composite set of assessments derived from a self-reported cognition questionnaire was administered to all respondents (Herzog & Wallace, 1997; Lachman & Spiro, 2002). The global measure of cognitive functioning consisted of seven items: immediate episodic memory (10 points), delayed episodic memory (20 points), serial 7s (5 points), backward counting (2 points), naming the day of the week and the date (4 points), naming two objects (2 points), and naming the current president and vice president of the United States (2 points). The first two constitutes "episodic memory" sector and the other five items add up together as "mental status" sector of individual cognitive functioning. The sum of episodic memory and mental status was then computed to assess the global cognitive functioning, and the score ranged from 0 to 35. Cronbach's Alpha was 0.85 across four waves.

For mild cognitive impairment, currently there is no consensus on the definition and criteria, and of multiple available measurements, this study chose to use the criteria of aging-associated cognitive decline (AACD) to define mild cognitive impairment. This is also in accordance with the criteria used in CHARLS study. The definition is: at least one standard deviation (SD) below the age-appropriate norms (Gilles, 2003; Levy, 1994). AACD covers basically all criteria for mild cognitive impairment and has been widely used as diagnostic criteria for mild cognitive decline by both clinicians and scholars, therefore fitting the aim of this study (Richards et al., 1999). In this study, respondents were divided into different age groups, with 5-year internals (e.g., 51-55, 56-60, 61-65……). Following that, group means (age-appropriate norms) and SDs of the cognitive functioning scores were calculated. Respondents who scored lower than one SD from the mean in the follow-ups were defined as mild cognitive impairment. Of 8,152 respondents, 1,282 experienced mild cognitive impairment in the following three waves (2012, 2014 and/or 2016).

Similarly, for episodic memory and mental status, groups means and SDs for different age groups were calculated, and one SD from the mean was defined as the cut for impairment. Separately, 1,641 and 1,350 respondents experienced mild impairment in episodic memory and mental status.

3.2.3.2. Independent Variables

Adverse childhood experiences included a comprehensive set of self-reported life conditions before 16 years of age in this study: early parental death, family SES, family relations, and childhood health. Early parental death consisted of paternal and maternal death (yes or no) before age 16.

Family SES was made up of three components: father's occupation, father's education and family economic hardship, since fathers were generally regarded as the main bread winners of the family, and family economic hardship was also included as a supplement as some respondents reported early parental divorce or paternal death. For father's education, the question was "what was your father's occupation when you were age 16?", and options included managerial/professional, sales, clerical, service, manual/operators, armed forces etc. The variable was dichotomized (manual=1, otherwise=0): Preliminary analysis shows that manual work consisted of 56.2% of all responses, therefore the variable is dichotomized to reduce confusion caused by the multiple options. Moreover, manual/operators generally had lower levels of income, therefore it was defined as one part of ACE. Similarly, father's education (<=middle school=1, otherwise=0) was dichotomized. Family economic hardship was measured by asking "would you say your family during childhood was pretty well off financially, about average, or poor?" Of the three options, "poor" was coded as economic hardship.

Family relations included poor relationships with parents and abuse from parents. Poor relationships with parents were measured by asking if the respondent agreed with the following statement "I had a good relationship with my mother/father before age 16." Of all the answers, "strongly disagree" and "disagree" were coded as yes, "neither agree nor disagree," "agree," and "strongly agree" were coded as no. Abuse from parents was measured by asking "before you were 18 years old, were you ever physically abused by either of your parents?" Answers included yes and no.

Childhood health consisted of poor physical health and mental health. Physical health was measured by asking respondents, "would you say that your health during childhood was excellent, very good, good, fair, or poor?" Of all answers, "fair" and "poor" were coded as yes, and the rest three were coded as no. For mental health, the question was worded as "before you were 16 years old, did you have depression?" Options included yes and no.

3.2.4. Moderators

Moderators include gender (male=1) and adulthood educational attainment. Respondents were asked "What is the highest grade of school or year of college you completed?" Answers included "0= No formal education" "1-11 years" "high school" "some college" "college grad" and "post college". Preliminary data analysis showed that more than 82% of respondents had an educational attainment of high school or above; Based on that the variable was dichotomized into dummy (1=high school or above, 0=otherwise).

3.2.5. Covariates

Age (in years), U.S. born (yes=1), race (1=White/Caucasian, 2=Black/African American, 3=Other), education (>=high school=1), and marital status (married=1) were used as demographic covariates. Moreover, adulthood health and health behaviors such as smoking (yes=1), drinking (yes=1), adulthood self-rated health (poor/very poor=1) and social engagement (number of social activities that the respondents participated in: care for sick/disabled adult; activities with grandchildren, nieces/nephews or neighborhood children; do volunteer work with children or young people; other volunteer or charity work; attend an educational or training course; go to a sport, social or other club; attend meetings of non-religious organizations; pray privately in places other than a church or synagogue; read books, magazines or newspapers; watch television; do word games such as crossword puzzles or scrabble; play cards or games such as chess; do writing, use a computer for email, internet of other tasks; do home or car maintenance or gardening; bake or cook something special; make clothes, knit, embroider; work on a hobby or project; play sports or exercise, walk for 20 minutes or more) were also included. Baseline data for these covariates were used as non-time-varying variables.

3.2.6. Statistical Analysis

Data multiple imputation was conducted using SPSS 24.0.0.0, and data analysis was carried out using R software (version 1.3.1093). Descriptive statistics of the imputed data were summarized in Table 3-1 using the baseline data and the life history data (For summary statistics of data before imputation, please refer to Appendix C). Chi-square tests and paired t-tests were also employed. Cox proportional hazard models, regressing ACEs on mild cognitive impairment were carried out for the whole sample, male and female subsample separately, and results were shown in Tables 3-2 and 3-3. Similarly, taking episodic memory impairment and mental status impairment as dependent variables separately, cox proportional hazard models were carried out for the whole sample, male subsample and female subsample, and results were summarized from Table 3-4 to Table 3-7. Sensitivity analyses were also conducted, comparing the results of respondents with complete answers with results obtained after imputations. No significant differences regarding the effects of ACEs and the moderating effects of education were found.

3.3. Results

Table 3-1 summarized the demographic, childhood as well as baseline cognitive functioning characteristics of the study sample. On average there were more female respondents and most of them were U.S.-born and white/Caucasian. The average educational levels were quite high: more than 80% of the respondents went to high school. In terms of ACEs, the percentage of early paternal death (7.51%) is much higher than that of early maternal death (0.21%). As for childhood SES, about half respondents' fathers had manual-related jobs (56.23%) and were less educated (47.63%), also one third reported experiencing economic hardship during childhood (31.56%). For family relations, 17.72% and 24.56% reported poor relationships with mother and father separately, and 5.89% were abused by parents. Few reported poor childhood health and only 1.73% were depressed before age 16. In terms of baseline cognitive functioning, the respondents scored 22.84 out of 35 for the total score: 9.84/20 for episodic memory and 13/15 for mental status.

For male and female subsample comparison, obviously a greater proportion of male respondents were married. There were no significant gender differences in terms of educational levels. Moreover, the male subsample was more likely to smoke and drink alcohol, still they rated themselves as in better health conditions than the female subsample. As for ACEs, the male subsample was more likely to experience early parental death, and childhood family economic hardship. However, they tended to have better relationships with both father and mother and were less likely to be abused by parents. They also rated themselves healthier and were less likely to have depression during childhood than the female counterparts. There were no significant gender differences in terms of mean age. When it comes to baseline cognitive functioning, the female subsample scored significantly higher (23.04/35) than the male subsample

(22.56/35). The female subsample also scored higher in terms of episodic memory (10.23/20) but lower for mental status (12.81/15).

Table 3-1. Sample Characteristics (Baseline Year 2010)

	Total (*N*=8,152)	**Missingness**	**Male** (*N*=3,364)	**Female** (*N*=4,788)
Categorical Variables	**%**	**%**		
Male	41.27	0		
U.S.-Born	90.34	0.04	90.00	90.58
Married/Partnered	58.92	0	74.94	47.66***
Race				
White/Caucasian	84.07	0	85.37	83.15***
Black/African America	12.79	0	10.97	14.08***
Other	3.14	0	3.66	2.78***
Education:>=High School	82.59	0	82.94	82.35
Smoking	8.67	0	9.22	8.29*
Drinking	53.52	0	62.90	46.93***
Poor Adulthood Health	22.52	1.32	21.67	23.12*
Early Paternal Death	7.51	0	8.95	6.50***
Early Maternal Death	0.21	0	0.24	0.19
Father: <=Middle school	47.73	0	46.05	48.91*
Father: Manual	56.23	0	56.63	55.95
Economic Hardship	31.56	0	34.45	29.53***
Poor Relations with Mother	17.72	4.20	13.39	20.72***
Poor Relations with Father	24.65	7.29	24.19	24.97
Abuse from Parents	5.89	7.55	5.06	6.46**
Poor Childhood Physical Health	5.90	0	5.23	6.37*
Childhood Depression	1.73	0	1.34	2.01*
Continuous Variables	**Mean**			
Age	73.89	0	73.70	74.02
Social Engagement	5.67	0	6.57	5.85**
Baseline Cognition	22.84	0	22.56	23.04***
Word Recall	9.84	0	9.28	10.23***
Mental	13.00	0	13.28	12.81***

Notes: Chi-square tests and paired t-tests were carried out to compare gender group differences; ^{+}P< .10; *P< .05; **P< .01; ***P< .001.

3.2.1. Mild Cognitive Impairment as Health Outcome

When estimating the associations between various ACEs and risk of mild cognitive impairment, to avoid co-linearity of various ACEs, correlation analysis was carried out and results were summarized in Appendix D. Most coefficients are small and close to 0. Between poor relations with mother and poor relations with father exists the largest correlation (0.432), indicating a moderate correlation. Therefore, various ACE indicators were not combined and included them separately for more detailed examination and interpretation. Cox proportional hazard models were applied to estimate the risk of mild cognitive impairment depending on ACEs and covariates for the whole sample, and the results were summarized in Table 3-2.

In Models 1 and 2, ACEs and adulthood demographic characteristics were used as independent variables separately: nearly all demographic and health characteristics were significant, for instance male (HR=1.11, 95% CI: [1.00-1.32], P<0.05) and adulthood educational attainment (HR=0.49, 95% CI: [0.43-0.55], P <0.001); as for ACEs, early paternal death (HR=1.29, 95% CI: [1.05-1.76], P <0.05), father's education (HR=1.20, 95% CI: [1.05-1.37], P <0.01) and father's job as manual worker (HR=1.25, 95% CI: [1.09-1.44], P <0.01), poor relations with mother (HR=0.83, 95% CI: [0.58-1.00], P <0.05) and poor childhood physical health (HR=1.46, 95% CI: [1.16-1.84], P <0.01) were significant. Both ACEs and covariates were included simultaneously in Model 3, and results showed that holding covariates constant, early paternal death (HR=1.49, 95% CI: [1.08-2.05], P <0.05) and poor childhood physical health (HR=1.18, 95% CI: [1.04-1.49], P <0.05) were significantly related to risk of mild cognitive impairment, and these associations were in the predicted direction: father's death and poor childhood physical health increased the hazard of mild cognitive impairment in later life by 49% and 18. % separately. Results also showed that family economic hardship (HR=0.85, 95% CI: [0.73-0.97], *P* <0.05) was significantly associated with risk of mild cognitive impairment, meaning that the hazard decreased by 15% when the respondent experienced economic hardship during childhood.

In Model 4, adulthood educational attainment was added as the moderator, and interaction terms were included in the model. Most demographic and health characteristics remained significant. Results showed that early paternal death (HR=2.20, 95% CI: [1.34-3.62], *P* <0.01) and father's job (HR=1.21, 95% CI: [1.03-1.58], *P* <0.01) remained significant, and the coefficient increased for both ACEs. The interaction between early paternal death and education was significant (HR=0.56, 95% CI: [0.29-0.99], *P* <0.05), indicating that when the individual had an education of high school or above, the cognitive hazards caused by early paternal death would be significantly reduced by 44%. In addition to that, the interaction between abuse from parents (HR=0.60, 95% CI: [0.34-0.97], *P* <0.05) and adulthood education was also significant.

Table 3-3 examined gender differences. Model 1 and 3 included ACEs and covariates only, and in Model 2 and 4, interactions were included. For the male subsample, only poor childhood physical health (HR=1.37, 95% CI: [1.03-2.01], *P* <0.05) remained significant, and economic hardship (HR=0.74, 95% CI: [0.59-0.92], *P* <0.01) became significant. However, when adulthood educational attainment was included as the moderator in Model 2, there were neither significant ACEs nor interactions.

For the female subsample, various ACEs were significant in Model 3: early paternal death (HR=2.12, 95% CI: [1.34-3.34], *P* <0.01), father's job (HR=1.14, 95% CI: [1.05-1.36], *P* <0.05), poor relations with mother (HR=0.79, 95% CI: [0.62-0.92], *P* <0.05) and poor relations with father (HR=1.27, 95% CI: [1.03-1.57], *P* <0.01) were significant, indicating the protective effect of poor relations with mother, and detrimental effects of other ACEs. In Model 4, when adulthood educational attainment was added as the moderator, early paternal death (HR=3.56, 95% CI: [1.68-7.49], *P* <0.001) and abuse from parents (HR=1.51, 95% CI: [1.08-2.59], *P* <0.05) were significant, and their interactions with adulthood educational attainment were also significant, meaning that having an educational attainment of high school or above greatly reduced the risks caused by early paternal death and abuse from parents for the female subsample.

Table 3-2. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mild Cognitive Impairment in Later Life (Whole Sample)

	Model 1		Model 2		Model 3		Model 4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	.00	.00-.00			.00	.00- .00	.00	.00 - .00
Early Paternal Death	1.29*	1.05-1.76			1.49	1.08-2.05	2.20**	1.34-3.62
Father: <=Middle school	1.20**	1.05-1.37			1.00	.88-1.15	.91	.72-1.13
Father: Manual	1.25**	1.09-1.44			1.14	.98-1.30	1.21*	1.03-1.58
Economic Hardship	1.06	.93-1.22			.85*	.73- .97	.96	.76-1.22
Poor Relations with Mother	.83*	.58-1.00			.92	.75-1.12	.80	.55-1.16
Poor Relations with Father	1.11	.94-1.30			1.10	.93-1.30	1.01	.75-1.36
Abuse from Parents	1.04	.78-1.38			1.08	.82-1.44	1.50	.96-2.32
Poor Physical Health	1.46**	1.16-1.84			1.18*	1.04-1.49	1.02	.71-1.46
Childhood Depression	1.12	.70-1.79			1.03	.65-1.64	1.09	.52-2.28
Interactions								
Early Maternal Death x Edu							.00	.00- .00
Early Paternal Death x Edu							.56*	.29- .99
Father: <=Middle school x Edu							.89	.66-1.18
Father: Manual x Edu							.91	.66-1.24
Economic Hardship x Edu							1.06	.79-1.41
Poor Relations with Mother x Edu							1.22	.79-1.87
Poor Relations with Father x Edu							1.15	.80-1.64
Abuse from Parents x Edu							.60*	.34- .97
Poor Physical Health x Edu							1.34	.83-2.14
Childhood Depression x Edu							.93	.35-2.40
Demographics								
Age			1.02**	1.01-1.03	1.04**	1.02-1.05	1.04***	1.23-1.05
Male			1.11*	1.00-1.26	1.12*	1.02-1.29	1.12*	1.03-1.29
U.S.-Born			1.02	.86-1.23	1.11	.88-1.40	1.08	.86-1.36
Married/Partnered			.94	.83-1.06	.95	.82-1.08	.95	.82-1.09
Race								

Black/African America	1.66*	1.44-1.92	1.71**	1.43-2.03	1.69***	1.42-2.02
Other	1.47*	1.09-1.97	1.32	.88-1.98	1.29	.85-1.95
Education:>=High School	.49*	.43- .55	.50*	.43- .57	.52***	.37- .72
Smoking	1.46*	1.22-1.75	1.56***	1.25-1.93	1.57***	1.26-1.95
Drinking	.69*	.62- .78	.65***	.56- .74	.64***	.56- .74
Social Engagement	.97**	.96- .98	.97***	.96- .98	.97***	.96- .98
Poor Adulthood Health	1.77*	1.56-1.99	1.81**	1.57-2.07	1.81***	1.57- 2.08

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

Table 3-3. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mild Cognitive Impairment in Later Life (Male and Female Subsample)

	Male				Female			
	Model 1		Model 2		Model3		Model4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	.00	.00- .00	.00	.00- .00	.00	.00- .00	.00	.00- .00
Early Paternal Death	1.07	.67-1.68	1.51	.76-3.01	2.12**	1.34-3.34	3.56***	1.68-7.49
Father: <=Middle school	.74**	.59- .92	1.15	.77-1.70	.93	.87-1.23	.93	.67-1.21
Father: Manual	1.10	.88-1.37	1.19	.75-1.88	1.14*	1.05-1.36	1.22	.88-1.71
Economic Hardship	.99	.79-1.23	.88	.61-1.25	1.04	.78-1.12	.90	.69-1.24
Poor Relations with Mother	1.19	.87-1.64	.90	.49-1.62	.79*	.62- .92	.77	.48-1.24
Poor Relations with Father	.87	.66-1.14	.86	.54-1.37	1.27*	1.03-1.57	1.10	.74-1.64
Abuse from Parents	1.12	.69-1.82	1.47	.67-3.21	1.04	.73-1.47	1.51*	1.08-2.59
Poor Physical Health	1.37*	1.03-2.01	1.08	.57-2.05	1.11	.82-1.49	.99	.64-1.56
Childhood Depression	.91	.37-2.24	1.39	.41-4.73	1.07	.61-1.85	.91	.36-2/33
Interactions								
Early Maternal Death x Edu			.00	.00- .00			.00	.00- .00
Early Paternal Death x Edu			.58	.23-1.42			.48*	.19- .78
Father: <=Middle school x Edu			.76	.48-1.19			1.22	.84-1.76
Father: Manual x Edu			.93	.55-1.58			.91	.61-1.34
Economic Hardship x Edu			.81	.50-1.31			1.01	.70-1.46
Poor Relations with Mother x Edu			1.51	.74-3.08			1.05	.60-1.82
Poor Relations with Father x Edu			1.01	.57 -1.8			1.23	.76-1.96
Abuse from Parents x Edu			.67	.25-1.84			.55*	.27- .74
Poor Physical Health x Edu			1.51	.68-3.36			1.21	.67-2.21
Childhood Depression x Edu			.46	.07-2.93			1.30	.41-4.14

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

3.2.2. Episodic Memory Impairment as Health Outcome

Similarly, Cox proportional hazard models were applied to estimate the risk of episodic memory impairment depending on ACEs and covariates for the whole sample, male subsample and female subsample separately in Table 3-4 and 3-5. In Table 3-4, For the whole sample, in Model 1, early paternal death (HR=2.18, 95% CI:[1.86-2.56], P<0.001), father's education (HR=1.16, 95% CI:[1.07-1.27], P <0.001) and father's job (HR=1.18, 95% CI:[1.08-1.29], P <0.001) were significant ACEs, and the associations were in the expected direction. Both gender (HR=1.57, 95% CI:[1.45-1.69], P <0.001) and adulthood educational attainment (HR=0.73, 95% CI:[0.67-0.80], P <0.001) were significant demographics in Model 2. After controlling the covariates in Model 3, early paternal death (HR=2.05, 95% CI:[1.73-2.43], P <0.001), father's education (HR=1.07, 95% CI:[1.03-1.24], P <0.05) and father's job (HR=1.13, 95% CI:[1.03-1.24], P <0.01) remained significant, and family economic hardship (HR=0.89, 95% CI:[0.82-0.98], P <0.05) as well as abuse from parents (HR=1.16, 95% CI:[1.06-1.39], P <0.05) became significant. Lastly, in Model 4, when interactions with adulthood educational attainment were included, only early paternal death (HR=2.57, 95% CI:[1.86-3.53], P <0.001) and abuse from parents (HR=1.53, 95% CI:[1.09-2.15], P <0.05) were significant ACEs, and their interactions with adulthood educational attainment were also significant, indicating that if the individual has an education of high school or above, the detrimental effects of both ACEs were reduced significantly.

In Table 3-5, For the male subsample, ACEs such as early paternal death (HR=1.94, 95% CI:[1.27-2.96], P <0.01) and poor relations with father (HR=0.76, 95% CI:[0.53-0.96], P <0.05 in Model 4) were significant across both models, while family economic hardship was only significant in the interaction model (HR=0.81, 95%

CI:[0.62-0.94], *P* <0.01). However, there were no significant interactions between ACEs and adulthood educational attainment, and this is similar to the interaction results of the male sample in terms of mild cognitive impairment.

The female subsample exhibited a different scenario. In Model 3, only early paternal death (HR=3.17, 95% CI:[2.46-4.08], *P* <0.001) and father's job (HR=1.15, 95% CI:[1.01-1.30], *P* <0.05) were significant. After including the interactions in Model 4, early paternal death (HR=3.80, 95% CI:[2.28-6.31], *P* <0.001) remained significant; Apart from that, abuse from parents (HR=1.59, 95% CI:[1.04-2.44], *P* <0.05) also became significant, and its interaction with adulthood educational attainment (HR=0.60, 95% CI:[0.36-0.99], *P* <0.05) was significant as well as in the expected direction: higher levels of educational attainment significantly reduced the risks of impaired episodic memory caused by abuse from parents for the female subsample.

Table 3-4. Cox Proportional Hazard Model of Adverse Childhood Experiences on Episodic Memory Impairment in Later Life (Whole Sample)

	Model 1		Model 2		Model 3		Model 4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
ACEs								
Early Maternal Death	.00	.00- .00			.00	.00- .00	.00	.00- .00
Early Paternal Death	2.18***	1.86-2.56			2.05***	1.73-2.43	2.57***	1.86-3.53
Father: <=Middle school	1.16***	1.07-1.27			1.07*	.98-1.17	1.00	.83-1.20
Father: Manual	1.18***	1.08-1.29			1.13**	1.03-1.24	1.13	.93-1.38
Economic Hardship	1.05	.95-1.14			.89*	.82- .98	.92	.77-1.09
Poor Relations with Mother	.93	.92-1.05			1.01	.89-1.15	.92	.70-1.22
Poor Relations with Father	.98	.88-1.09			.95	.85-1.06	.87	.69-1.10
Abuse from Parents	1.10	.92-1.32			1.16*	1.06-1.39	1.53*	1.09-2.15
Poor Physical Health	1.08	.90-1.28			.96	.82-1.15	1.00	.75-1.33
Childhood Depression	.88	.63-1.24			.84	.61-1.19	.91	.47-1.74
Interactions								
Early Maternal Death x Edu							.00	.00- .00
Early Paternal Death x Edu							.75*	.52- .97
Father: <=Middle school x Edu							1.08	.88-1.34
Father: Manual x Edu							1.00	.80-1.25
Economic Hardship x Edu							.96	.78-1.18
Poor Relations with Mother x Edu							1.13	.83-1.54
Poor Relations with Father x Edu							1.12	.86-1.47
Abuse from Parents x Edu							.68*	.46- .83
Poor Physical Health x Edu							.95	.67-1.36
Childhood Depression x Edu							.92	.43-1.97
Demographics								
Age			1.00	.99-1.01	1.01***	1.00-1.02	1.01***	1.01-1.02
Male			1.57***	1.45-1.69	1.56***	1.43-1.71	1.57***	1.43-1.71
U.S.-Born			.90*	.79-1.01	.91	.79-1.05	.90	.77-1.04
Married/Partnered			.87**	.81- .95	.88**	.80- .96	.88**	.81- .96

Race						
Black/African America	1.45***	1.31-1.60	1.44***	1.27-1.63	1.44***	1.27-1.63
Other	1.46***	1.20-1.77	1.19	.91-1.56	1.17	.89-1.54
Education:>=High School	.73***	.67- .80	.72***	.65- .80	.70**	.52- .89
Smoking	1.25***	1.13-1.44	1.33***	1.15-1.54	1.33***	1.15-1.54
Drinking	.78***	.73- .84	.77***	.71- .84	.77***	.70- .84
Social Engagement	.98***	.98- .99	.99**	.98- .99	.99**	.98- .99
Poor Adulthood Health	1.48***	1.37-1.62	1.56***	1.42-1.72	1.56***	1.42-1.72

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

Table 3-5. Cox Proportional Hazard Model of Adverse Childhood Experiences on Episodic Memory Impairment in Later Life (Male and Female Subsample)

	Male				Female			
	Model 1		Model 2		Model3		Model4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	.00	.00- .00	.00	.00- .00	.00	.00- .00	.00	.00- .00
Early Paternal Death	1.55***	1.23-1.95	1.94**	1.27-2.96	3.17***	2.46-4.08	3.80***	2.28-6.31
Father: <=Middle school	1.11*	1.07-1.26	1.16	.87-1.54	1.07	.95-1.21	.97	.75-1.23
Father: Manual	1.11*	1.07-1.26	1.02	.75-1.40	1.15*	1.01-1.30	1.19	.91-1.56
Economic Hardship	.83**	.73- .95	.81**	.62- .94	.95	.84-1.09	.99	.78-1.24
Poor Relations with Mother	1.13	.93-1.37	.92	.61-1.43	.95	.81-1.12	.97	.68-1.30
Poor Relations with Father	.84*	.71- .98	.76*	.53- .96	1.07	.91-1.24	.94	.68-1.30
Abuse from Parents	1.19	.90-1.57	1.32	.74-2.35	1.10	.86-1.41	1.59*	1.04-2.44
Poor Physical Health	.94	.71-1.23	.90	.55-1.47	1.00	.80-1.26	1.03	.71-1.47
Childhood Depression	.94	.56-1.58	.74	.22-2.42	.77	.49-1.20	.94	.42-2.06
Interactions								
Early Maternal Death x Edu			.00	.00- .00			.00	.00- .00
Early Paternal Death x Edu			.74	.45-1.20			.80	.45-1.41
Father: <=Middle school x Edu			.94	.69-1.29			1.15	.87-1.52
Father: Manual x Edu			1.11	.79-1.56			.95	.70-1.29
Economic Hardship x Edu			1.04	.77-1.40			.95	.71-1.26
Poor Relations with Mother x Edu			1.28	.79-2.06			.98	.66-1.48
Poor Relations with Father x Edu			1.13	.77-1.67			1.18	.81-1.70
Abuse from Parents x Edu			.87	.44-1.68			.60*	.36- .99
Poor Physical Health x Edu			1.05	.58-1.88			.96	.60-1.52
Childhood Depression x Edu			1.44	.39-5.39			.76	.30- 1.98

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

3.2.3. Mental Status Impairment as Health Outcome

Lastly, Tables 3-6 and 3-7 summarized the results of Cox proportional hazard models that used mental status impairment as dependent variable for the whole sample, male subsample and female subsample separately. In Table 3-6, for the whole sample, apart from early paternal death (HR=1.68, 95% CI:[1.39-2.02], P<0.001), father's education (HR=1.14, 95% CI:[1.04-1.24], P <0.001) and father's job (HR=1.23, 95% CI:[1.12-1.35], P <0.001), in Model 1 abuse from parents (HR=1.17, 95% CI:[1.08-1.41], P <0.05), poor physical health (HR=1.24, 95% CI:[1.05-1.47], P <0.05) and childhood depression (HR=1.36, 95% CI:[1.02-1.81], P <0.05) were also significantly associated with higher risks of mental status impairment in later life. In Model 2, gender as male (HR=0.81, 95% CI:[0.74-0.88], P <0.001) was significant and this is different from previous findings: gender as male significantly increased the risks of mild cognitive impairment and episodic memory impairment, while for male respondents, the risks of mental status impairment were significantly reduced. Moreover, adulthood educational attainment (HR=0.60, 95% CI:[0.55-0.66], P <0.001) was significant across all models. After controlling all the covariates in Model 3, early paternal death (HR=1.78, 95% CI:[1.47-2.17], P <0.001), father's job (HR=1.14, 95% CI:[1.04-1.26], P <0.01), abuse from parents (HR=1.19, 95% CI:[1.00-1.43], P <0.05) and childhood depression (HR=1.25, 95% CI:[1.04-1.67], P <0.05) remained significant. Family economic hardship (HR=0.88, 95% CI:[0.80-0.97], P <0.01) became significant. When adulthood educational attainment was added as the moderator in Model 4, early paternal death (HR=1.66, 95% CI:[1.12-2.45], P <0.05) and economic hardship (HR=0.88, 95% CI:[0.74-0.94], P<0.05) were significant ACEs, and only interactions between poor physical health and adulthood educational attainment (HR=1.42, 95% CI:[1.00-2.03], *P* <0.05) was significant.

In Table 3-7, for the male subsample had different results with those of the whole sample: after controlling all the demographics in Model 1, early paternal death (HR=1.29, 95% CI:[1.09-1.77], *P* <0.05), father's occupation (HR=1.16, 95% CI:[1.08=1.37], *P* <0.05), family economic hardship (HR=0.77, 95% CI:[0.65-0.91], *P* <0.01) and poor relations with father (HR=0.84, 95% CI:[0.69-0.945) became significant. In the interaction Model 2, only family economic hardship (HR=0.76, 95% CI:[0.56-0.92], *P*<0.05) remained as a significant ACE factor, and interactions between education and poor relationship with mother (HR=1.90, 95% CI:[1.08-3.36], *P* <0.05), education and poor physical health (HR=2.19, 95% CI:[1.08-4.36], *P* <0.05) were significant --- all in the "unexpected" directions: family economic hardship could reduce the risks of mental status impairment, while higher levels of adulthood educational attainment might increase the risks caused by childhood poor relations with mother and poor physical health for the male subsample.

For the female subsample, in Model 3 only early paternal death (HR=2.29, 95% CI:[1.78-2.95], *P* <0.001) and abuse from parents (HR=1.20, 95% CI:[1.07-1.49], *P* <0.05) were significantly associated with higher risks of mental status impairment. And in the interaction Model 4, the only significant ACE was early paternal death (HR=2.23, 95% CI:[1.30-3.81], *P* <0.01), and there were no significant interactions between any ACEs and adulthood educational attainment for the female subsample.

Table 3-6. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mental Status Impairment in Later Life (Whole Sample)

	Model 1		Model 2		Model 3		Model 4	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
ACEs								
Early Maternal Death	.39	.05-2.81			.40	.05-2.86	.38	.05-2.76
Early Paternal Death	1.68***	1.39-2.02			1.78***	1.47-2.17	1.66*	1.12-2.45
Father: <=Middle school	1.14**	1.04-1.24			1.01	.92-1.10	.94	.79-1.12
Father: Manual	1.23***	1.12-1.35			1.14**	1.04-1.26	1.11	.92-1.35
Economic Hardship	1.02	.92-1.12			.88**	.80- .97	.88*	.74- .94
Poor Relations with Mother	1.02	.90-1.16			1.05	.92-1.19	.87	.67-1.14
Poor Relations with Father	.96	.85-1.07			.96	.86-1.08	.98	.78-1.23
Abuse from Parents	1.17*	1.08-1.41			1.19*	1.00-1.43	1.23	.87-1.72
Poor Physical Health	1.24*	1.05-1.47			1.02	.86-1.21	.83	.62-1.10
Childhood Depression	1.36*	1.02-1.81			1.25*	1.04-1.67	1.17	.68-2.04
Interactions								
Early Maternal Death x Edu							.00	.00- .00
Early Paternal Death x Edu							1.09	.70-1.69
Father: <=Middle school x Edu							1.09	.89-1.34
Father: Manual x Edu							1.03	.83-1.29
Economic Hardship x Edu							1.00	.82-1.22
Poor Relations with Mother x Edu							1.26	.94-1.71
Poor Relations with Father x Edu							.98	.75-1.28
Abuse from Parents x Edu							.95	.63-1.42
Poor Physical Health x Edu							1.42*	1.00-2.03
Childhood Depression x Edu							1.10	.57-2.08
Demographics								
Age			1.00	.99-1.01	1.02***	1.01-1.02	1.02***	1.01-1.02
Male			.81***	.74- .88	.80***	.73- .88	.80***	.73- .89
U.S.-Born			.93	.83-1.06	.95	.82-1.10	.94	.81-1.09
Married/Partnered			.88**	.81- .95	.89*	.82- .98	.90*	.82- .98
Race								

Black/African America	1.62***	1.47-1.80	1.69***	1.50-1.90	1.67***	1.48-1.89
Other	1.37**	1.11-1.69	1.25	.94-1.65	1.26	.95-1.67
Education:>=High School	.60***	.55- .66	.59***	.53- .65	.51***	.41- .64
Smoking	1.42***	1.26-1.61	1.48***	1.28-1.72	1.45***	1.29-1.72
Drinking	.78***	.72- .84	.75***	.68- .82	.75***	.68- .82
Social Engagement	.98***	.97- .99	.99***	.98- .99	.99***	.98- .99
Poor Adulthood Health	1.56***	1.43-1.70	1.58***	1.43-1.74	1.58***	1.43-1.74

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

Table 3-7. Cox Proportional Hazard Model of Adverse Childhood Experiences on Mental Status Impairment in Later Life (Male and Female Subsample)

	Male				Female			
	Model 1		Model 2		Model3		Model4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
ACEs								
Early Maternal Death	.00	.00- .00	.00	.00- .00	1.30	.18-9.39	1.29	.17-9.34
Early Paternal Death	1.29*	1.09-1.77	1.13	.62-2.03	2.29***	1.78-2.95	2.23**	1.30-3.81
Father: <=Middle school	.98	.83-1.15	1.04	.75-1.42	1.03	.93-1.15	.91	.74-1.12
Father: Manual	1.16*	1.08-1.37	.97	.68-1.38	1.13	1.01-1.27	1.15	.92-1.45
Economic Hardship	.77**	.65- .91	.76**	.56- .92	.94	.84-1.06	.92	.76-1.13
Poor Relations with Mother	1.20*	.94-1.52	.75	.46-1.23	.99	.85-1.15	.94	.69-1.29
Poor Relations with Father	.84*	.69- .94	1.01	.69-1.47	1.02	.88-1.17	.93	.70-1.25
Abuse from Parents	1.10	.76-1.59	1.11	.58-2.14	1.20*	1.07-1.49	1.25	.84-1.87
Poor Physical Health	1.33*	1.00-1.79	.75	.41-1.37	.92	.74-1.14	.85	.61-1.19
Childhood Depression	1.32	.75-2.33	1.30	.45-3.75	1.22	.87-1.70	1.15	.69-2.20
Interactions								
Early Maternal Death x Edu			.00	.00- .00			.00	.00- .00
Early Paternal Death x Edu			1.18	.60-2.32			1.03	.57-1.88
Father: <=Middle school x Edu			.92	.64-1.34			1.18	.92-1.50
Father: Manual x Edu			1.26	.85-1.89			.97	.74-1.26
Economic Hardship x Edu			1.02	.72-1.46			1.03	.80-1.32
Poor Relations with Mother x Edu			1.90*	1.08-3.36			1.06	.74-1.51
Poor Relations with Father x Edu			.77	.49-1.20			1.12	.80-1.56
Abuse from Parents x Edu			.96	.43-2.11			.95	.59-1.52
Poor Physical Health x Edu			2.19*	1.09-4.36			1.16	.75-1.77
Childhood Depression x Edu			1.05	.29-3.65			1.10	.52-2.34

Notes: Coefficients have been exponentiated, and hazard ratios (HRs) were reported. +*P*< .10; **P*< .05; ***P*< .01; ****P*< .001.

3.4. Discussion

3.4.1. The Whole Sample --- Mild Cognitive Impairment, Episodic Memory Impairment and Mental Status Impairment

Focusing on the older adults in the United States, this study examined the associations between ACEs, adulthood educational attainment and mild cognitive impairment in later life, and explored the gender differences in the associations. Overall, findings revealed that for the whole sample, childhood SES, represented by father's job as manual laborer, was significantly associated with increased hazards of mild cognitive impairment even after controlling for adulthood characteristics. This is in accordance with the previous literature, confirming the direct effects that early socioeconomic adversity has on late-life health outcomes: lower levels of childhood SES was associated with a two-fold increase in offspring Alzheimer's Disease risk and faster rate of late-life cognitive decline in offspring (Norton, Ostbye, Smith, Munger, & Tschanz, 2009).

Other than childhood SES, early paternal death was especially significant, and this reflected the linked live principles of the life-course perspective, which emphasized the interdependent relationships among family members (Hagestad, 2003). For parent-child relationships, this principle implied that the individual characteristics and social resources associated with parents might influence the health and well-being of children. (Gimenez, Chou, Liu, & Liu, 2013; Li, Fu, Xue, & Wang, 2019). Early parental death is an unexpected and traumatic event which usually poses the greatest adaptive challenges thus introducing a host of potential stressors: These are not only economic but also psychosocial and may have a lifelong impact for individuals with inadequate access to social and emotional resources. Given that father was generally the main financial provider of the household, the death of a father, therefore, is expected to be more stressful than the death of a mother for the bereaved offspring. This study proposes two mechanisms that might explain the influence: first, from the biological point of view, the death of father in early life might lead to repeated physiological stress reactions over the life course, which further damages cognitive functioning through the death of neuronal cells (McEwen, 2002). Second, the acquisition of unhealthy lifestyles and behaviors might also link early parental death to late life cognitive functioning problems. For instance, the death of father has been studied as a risk factor of early drug use (Giordano, Ohlsson, Kendler, Sundquist, & Sundquist, 2014), which would be further related to higher risks of cognitive disorders (de Micheli, Andrade, da Silva, & de Souza Formigoni, 2016).

In addition to that, this study also found that abuse from parents in childhood was significantly related to higher risks of mild cognitive impairment in later life. This is new, since studies of older adults have generally found lower cognitive functioning in individuals exposed to childhood neglect, but have not found differences in cognitive functioning among those exposed to physical abuse, although studies have been limited by inadequate assessments of abuse, low prevalence of reported abuse or lack of measurement of abuse severity (Danese et al., 2017; Geoffroy, Pinto Pereira, Li, & Power, 2016). Of the few studies examining the relationship between childhood abuse and late life functioning, Feeney and colleagues (2013) studied the Irish aging population and found better global cognitive function and immediate episodic memory in participants who reported childhood abuse versus those who did not, and there were no differences in other cognitive measures; Ritchie and colleagues (2009) also found no differences in cognitive function by abuse history of respondents. Contrary to that, this study suggested the detrimental effects of childhood abuse on the cognitive functioning of older adults and put forward the following pathways: first, the extreme psychological stress of childhood abuse may cause alterations to the developing brain that reduce cognitive function across the life course (De Bellis, 2001; Hanson, Adluru, Chung, Alexander, Davidson, & Pollak, 2013). Second, higher prevalence of adulthood psychological distress in persons exposed to childhood abuse may lead to lower cognitive function, and third, exposure to childhood abuse may be more likely to be perpetrators of childhood abuse (Crandall, Deater-Deckard, & Riley, 2015; Johnson, Mash, Miller, & Ninowski, 2012; Mokrova, O'Brien, Calkins, & Keane, 2010) or children with poor cognitive function themselves were at elevated risk for abuse (Dubowitz, Kim, Black, Weisbart, Semiatin, & Magder, 2011; Jones et al., 2012; Spencer et al., 2005).

For adulthood characteristics, educational attainment was significantly associated with lower risks of mild cognitive impairment in later life. Such results echoed previous literature, confirming the protective influence of education and suggesting that education may increase competency and improve brain functions (Alley, Suthers, & Crimmins, 2007). What's more, significant interactions between ACEs and adulthood educational attainment have been found: Results show that if the individual has an educational attainment of high school or above, the detrimental effects caused by early parental death would decrease by 44.5%, and the effects from abuse would decrease by 39.6%. Such findings fit the cognitive reserve hypothesis, which suggested that people with higher reserve were more capable of tolerating the aging process and related disease, cognitive impairment and injury in brain and cognition (Stern, 2003). The theory put that the mental trainings in the form of education offered an additional capacity in cognition to compensate for the loss in early life and the decline in the late life (Whalley, Deary, Appleton, & Starr, 2004).

There were different scenarios for the two domains cognitive functioning: episodic memory and mental status. For episodic memory, the whole sample scored 9.84 out of 20 --- this is not high, indicating the lower levels of memory among the older adults. As for the ACEs, early paternal death, family SES (represented by father's education and father's job) and abuse from parents were significantly related to higher risks of episodic memory impairment. This is similar to the results for mild cognitive impairment. However, family economic hardship was found to significantly decreasing the risk. This is out of expectation, since previous literature revealed that economic hardship was associated with lower levels of cognitive function in late life and might even accelerate aging (Zeki Al Hazzouri et al., 2017). One hypothesis is the protective factors against the detrimental effects of childhood economic hardship: For instance psychological resilience. Studies have found that poor children sometimes have unexpectedly positive mental health and school outcomes, thanks to their high levels of psychological resilience (Rutter, 2012; Werner, 2005). In early childhood, sensitive and responsive caregivers, supportive peers and teachers and stable families all can buffer against the strains and stresses of economic hardship (Luthar, Crossman, & Small, 2015). Moreover, children themselves tend to exhibit individual resilience: active, effective interpersonal and communication skills, achievement motivation relate to school or other special talents, and strong self-control (Masten & Narayan, 2012; Rutter, 2012). All these might help explain the findings of this study: Despite poverty, some poor children remain in good health, and such extends into adulthood and late life (Chen & Miller, 2013). In terms of interactions with education, for episodic memory impairment, the results were in accordance with those of mild cognitive impairment: adulthood educational attainment significantly reduced the effects of early paternal death and abuse from parents. At the same time, adulthood educational attainment also directly reduced the risks of episodic memory impairment.

For the second domain of cognitive function, mental status, an additional significant ACE is childhood depression. Many studies have focused on adulthood depression and found that cognitive functioning in late life can be adversely affected (Bringer et al., 2005; Donovan, Wu, Rentz, Sperling, Marshall, & Glymour, 2017). However, few have taken childhood mental health into consideration, and childhood depression is seldom regarded as an important part of ACEs, possibly due to the low prevalence and parent neglect. In fact, childhood depression deserves special attention, considering the serious and lasting consequences of the disease to child development, ranging from physiological changes to the impairment of social and cognitive functions (Avanci, Assis, Oliveira, & Pires, 2012). Studies have also found that depressed children and adolescents showed evidence of functional impairment in various cognitive and social domains and actual school performance seemed to be more consistently affected by depression than intellectual abilities. Depressed children also appeared to be less social adept than peers and showed mild declines in verbal performance over time (Kendall, Stark, & Adan, 1990; Kovacs & Goldston, 1991). In this way, childhood depression might have long-lasting influences on the cognitive function into adulthood and late life. As for the interactions, only interaction between adulthood educational attainment and poor physical health was significant.

One more interesting and meaningful finding is that for mental health impairment, gender as male significantly reduced the risks; While for mild cognitive impairment and episodic memory impairment, gender as male increased the risks significantly. There are indeed great gender differences for the two domains of cognitive impairment, and these differences would be discussed in the following paragraphs.

3.4.2. The Male Subsample --- Mild Cognitive Impairment, Episodic Memory Impairment and Mental Status Impairment

For the male respondents included in this study, findings revealed that gender as male could significantly increase the risks of mild cognitive impairment in late life. This is different from previous findings and hypothesis, that females appeared to be at a higher risk of developing mild cognitive impairment and dementia. Studies revealed that for gender differences in cognition, females performed better on verbal and memory tasks, while men excel in spatial tasks (Gur & Gur, 2002). Studies have shown that females have higher initial scores on most types of cognitive tests except those measuring visuospatical ability, and they indeed had greater cognitive reserve than their male counterparts (McCarrey, An, Kitner-Triolo, Ferrucci, & Resnick, 2016). Reasons for these gender differences are complex and likely influenced by biological (e.g., sex hormones), genetic, social and cultural factors (Miller & Halpern, 2014).

As for the risk of mild cognitive impairment, family economic hardship and poor physical health were significant ACEs for the male subsample: similar to that of the whole sample, family economic hardship was a protective factor, while poor physical health increased the hazards of mild cognitive impairment. Moreover, despite the fact that adulthood educational attainment directly reduced the risk, there were no significant interactions between any ACEs and adulthood educational attainment. This meant that for the male respondents, having an education of high school or above would directly benefit their late life cognition by reducing the risk of impairment, however education could not buffer or moderate the detrimental effects of childhood adversities.

When it came to the episodic memory domain of cognitive functioning, results showed that early parental death, family economic hardship and poor relations with father were significant ACEs. Moreover, poor relations with father acted as a protective factor: The hazard risk of episodic memory impairment was reduced by 16.2% for the male subsample. The child development literature has long linked the emotional quality of family relationships to children's adjustment and development (Crosnoe & Cavannagh, 2010; Wyman, Cowen, Work, & Parker, 1991). Generally, it is found that positive child-parent relationship was linked to higher interest in school, lower life stress, while negative child-parent relationship were associated with more emotional problems and poor behavior outcomes such as drug use, smoking, alcohol consumption and theft (Fletcher, Steinberg, & Williams-Wheeler, 2004; Magnus, Cowen, Wyman, Fagen, & Work, 1999). Parental support could help children develop skills to deal with major adversities, promote sense of value and competence, and aid in the development of adaptive self-regulation mechanisms, which were related to cognitive development (Wyman et al., 1991). However, father-son relationship was often found to be rigid: it is generally more acceptable for mothers to show affection, and it might be more difficult for fathers to show affection toward their sons. For sons who developed poor relationships with father, often mothers would be more involved in their lives and compensate for the love and affection (Craig, 2006). This might be one reason why poor relations with father acted as protective factors for the male subsample only. Similarly, adulthood educational attainment only reduced the risks of episodic memory impairment directly, and did not have any significant interactions with ACEs, further confirming the life-long influences of early childhood conditions on late life cognition.

Lastly, for mental health impairment, there were more influencing ACEs for the male subsample: early paternal death, family SES, poor physical health, and poor relationships with both parents. Poor relations with mother increased the risk of mental health impairment by 19.6%, and this is consistent with previous literature on how early child-parent relationship quality influenced later life cognitive function (Peng, Burr, Yang, & Lu, 2021). Moreover, mothers were more likely to spend not only more time with their children, but also more overall responsibility for their care. According to the brain reserve capacity theory, a lack of early cognitive training could lower brain reserve and subsequently allow for cognitive problems to appear earlier in one's life course (Zhang et al., 1990). Therefore, it is plausible that the poor relations with mother in early life might disrupt the cognitive development of the children, which further leads to cognitive impairment in later life.

As for adulthood educational attainment, it remained as a directive protective factor for mental status impairment, and the interaction between adulthood educational attainment and poor physical health was significant in a detrimental way: if an individual has an educational attainment of high school or above, the risk of mental health impairment caused by poor physical health would increase by two-fold. Since poor physical health as an ACE was not significant in the first place, the interaction did not make much sense, and no further discussion would be included in this study.

3.4.3. The Female Subample --- Mild Cognitive Impairment, Episodic Memory Impairment and Mental Status Impairment

The female subsample scored higher in baseline cognition and episodic memory, but lower than their male counterparts in mental status. For mild cognitive impairment, early paternal death, family SES and relations with parents were significant ACEs. However it should be noted that poor relations with mother was protective and poor relations with father was hazardous for mild cognitive impairment. This is contrary to the results of the male subsample. The stormy mother-daughter relationship, often characterized by ambivalence and conflict, has been found to be beneficial to health development of individuals and the long-term relationships between girls and their mothers (Obeidallah & Burton, 1999). Such mother-daughter relationships in effect increased communication and contributed to activity sharing and advice giving and has the potential as a locus for health promotion, especially in the field of mental health and cognitive development (Mosavel, Simon, & Van Stade, 2011).

In terms of adulthood demographics, the female subsample shared similar results with the whole sample, that adulthood educational attainment significantly moderated the detrimental effects of early paternal death and abuse from parents. This re-confirmed the resource substitution theory, that education was more important to the health of individuals who were otherwise disadvantaged (Ross & Mirowsky, 2006). Females obviously had few alternative resources and were more dependent on education for health than males, who had more resources and therefore no significant interactions between education and any ACEs. The findings of this study fit the theory prediction, that education would interact with disadvantaged social origins, for instance education had a larger effect on health for individuals who grew up in families with lower levels of SES than it does for the more advantaged (Ross & Mirowsky, 2012). In this study, for the females only, adulthood educational attainment significantly moderated and buffered the risks of mild cognitive impairment caused by ACEs, while at the same time, adulthood educational attainment remained as a direct protective factor.

For the episodic memory impairment, the results were similar to those of mild cognitive impairment: Early paternal death and abuse from parents were significant ACEs, and the interaction between adulthood educational attainment and abuse from parents were significant, indicating effective moderating effects for the female subsample. Lastly, for mental health impairment, findings revealed that early paternal death remained significant, while there were no significant interactions between adulthood educational attainment and any ACEs. This indicated that the moderating effects of education was only effective for the episodic memory, but not for mental status of older female adults. One guess is that other than educational, female adults tend to rely on other psychosocial resources, for instance social support, family support and individual resilience to buffer the detrimental effects of ACEs on mental status.

3.5. Conclusion

Based on nationally representative and longitudinal dataset in the U.S., and by investigating the long-term impact of ACEs on mild cognitive impairment among older adults, this study revealed that childhood conditions such as early paternal death and family SES had long-lasting influences on cognitive health outcomes in later life, and education could buffer such influences. Domain analysis showed that only the episodic memory section of cognitive functioning benefited from education, while the mental status section did not. Moreover, under the resource substitution framework, this study found that females benefit more and only females benefit from the protective effects of adulthood educational attainment on late life cognition.

3.5.1. Policy Implications

To reduce mild cognitive impairment in later life, policy makers should pay more attention to reducing ACEs, especially family SES, family relations and childhood health by implementing interventions throughout the life course, starting from childhood. For instance, Alder and Newman (2002) argued that policies based on each component of SES could reduce health disparities in later life. Policies reducing exposure to poor residential and work environments (e.g. sanitary landfill and environmental justice), increasing social cohesion and social capital (e.g., investment in community infrastructure), increasing access to health care (e.g., universal health care and medicare), reducing economic inequality and promoting positive health-related behaviors (e.g., nutritional information campaigns) may enhance the cognitive health of individuals suffered from ACEs.

3.5.2. Study Limitations

This study has three limitations that need to be addressed. First, the multiple imputation assumed that the data missingness was random, and this study was not able to verify this assumption. Second, cognitive function was measured only among self-respondents living in the community at baseline, and sample selection bias related to having a relatively healthy sample of individuals living in the community may have been present as persons with the most serious cognition problems were likely living in institutions. Also, some potential respondents who were disadvantaged in childhood may have been excluded from the HRS because of the poor health or through mortality selection. Third, all childhood measures were based on self-reported retrospective questions. There exist recall bias and subjective report of these items. And last, some of the biological risk factors associated with health that may have been influenced by childhood and adulthood circumstances were not available for analysis in the HRS data.

3.5.3. Contributions

Despite the above-mentioned limitations, this study made several contributions to the research literature. First, this study used a long observation period to study cognitive functioning changes based on a life course approach. Although research has been reported using waves of HRS and childhood SES (Brown et al., 2014; Lyu & Burr, 2016), none has employed multiple childhood condition indicators reported here, and added adulthood educational education as a moderator. Second, apart from discussing mild cognitive impairment, this study also explored the two domains of cognitive functioning measurement: the episodic memory and mental status. Third, gender differences hypothesis also allowed for the test and verification of resource substitution theory. Fourth, by analyzing nationally representative data, more confidence was provided that the results were generalizable to a known population.

CHAPTER 4: U.S. and China: Comparison and Contrast

4.1. The Aging Population

Aging populations pose serious challenges for the health and long-term care systems around the globe, never before has the global population included as many older adults as it does today. The challenges are particularly acute in China, where demographics shifts are rapid, exacerbated by the profound socioeconomic changes (Hesketh, Lu, & Xing, 2005). The number of older people has increased rapidly at an unprecedented rate in the past few decades. By the end of 2019, the number of people aged 60 and older reached approximately 254 million, accounting for 18.1% of the total population in China (National Bureau of Statistics, 2020). It is estimated that the older population would account for more than 30% in 2050, bringing major challenges to the healthy development and security of the older people in China.

Meanwhile, the population aging process is global: Over the past century in the United States alone, the proportion of adults aged 65 years or older increased more than threefold, from 4.1% to 12.9% (U.S. Department of Health and Human Services). At least three major factors --- the aging of the baby boom generation (those born from 1956 through 1964), the growing number of persons living with multiple chronic conditions, and the reform of the U.S. health care system --- are promoting animated discussion and debate about aging in the United States. The population of older adults is undergoing dynamic growth in terms of racial and ethnic diversity, as well as changes in functional capacity. Although an aging population undoubtedly places pressure on policymakers as they seek to stem rising health care costs, insufficient attention has been focused on new approaches designed to improve community-based services, quality of life, and life experiences across the life course (Olshansky, Goldman, Zheng, Rowe, & Milbank, 2009).

Despite the common rapid aging process, the two countries had different aging patterns. In China, there's the dramatic expansion of the oldest-old population: the proportion of the oldest-old group (over 80 years old) reached 13.9% of the total aging population in 2015 (National Bureau of Statistics of China, 2019), and the annual average growth rate for the oldest-old population is almost three times that of the whole older population (The Population Division of the Department of Economic and Social Affairs of United Nations Secretariat, 2019). Also, there exists uneven aging distribution in China: for instance, the proportion of older females (12.2%) is higher than that of males (10.6%) aged 65 and above, and the gender gap tends to widen (Ministry of Civil Affairs of the People's Republic of China, 2017). Furthermore, the east-to-west geographic variations is apparent due to vast territory and economic disequilibrium, and the proportion of older adults in rural areas is higher than that in urban areas where the economic development is higher (Du & Wang, 2010; Huang & Tong, 2012).

While at the same time, the U.S. population is aging and increasingly diversifying by 2060. The immigrants are expected to comprise close to 26% of U.S. older adults (Colby & Ortman, 2015), and the country is welcoming more and more immigrants every year, bringing in new blood and energy: net migration rose from 0.8 to 1.9 million per year between 1980 and 2010. The current law would also change to allow more legal immigration, and since migrants are on average younger than the U.S. population, migration actually reduces population aging (Institute of Medicine Committee on the Long-Run Macroeconomic Effects of the Aging U.S. Population, 2012). Moreover, the birthrate of U.S. is even higher than that of China: 12 peer 1000 people in comparison of 10.48, rendering the widening differences in terms of aging patterns between two countries.

Cognitive maintenance is an important aspect of healthy aging (Zaninotto et al., 2018). Cognitive function includes attention, memory, language, processing speed, visuospatial ability, and executive function (Harada et al., 2013). Accumulating evidence has demonstrated that cognitive function progressively declines with age (Legdeur et al., 2017; Cornelis, Weintraub, & Morris, 2020), primarily due to the structural and functional changes in aging brains (Murman, 2015). Many studies have shown that cognitive aging leads to an increased risk of cognitive impairment and directly affects an individual's physical and mental condition, further decreasing the quality of life (Bettio, Rajendran, & Gil-Mohapel, 2017; Liang et al., 2019). The problem of cognitive aging accompanied by rapid older population growth is more prominent (Xiang, Zare, Guan, & Gaskin, 2018), which has drawn great attention of the academia. Using two nationally representative sister studies, China Health and Retirement Longitudinal Study (China) and Health and Retirement Study (U.S.), this study found that the two countries both shared similarities and had distinctive differences in aging characteristics as well as issues of cognitive impairment, which will be discussed below.

4.2. Sample Characteristics

There were more males in the Chinese sample but more females in the U.S. sample Moreover, in terms of the study moderator --- individual educational attainment, more than 80% of the U.S. population went to high school or higher, while only 30% of Chinese older adults had an educational level of middle school or above. This is within the expectation, since studies have found that while most elderly Chinese males had at least primary school levels of education, the vast majority of elderly females were illiterate, having significantly lower levels of education (Luo, Zhang, & Gu, 2015). While at the same time, the older adults in U.S. had obviously higher levels of educational attainment: the U.S. Census reported that almost 9 out of 10 adults (88%) had at least high school diploma, while nearly one in three (33%) held a bachelor's or higher degree (Ryan & Bauman, 2016). It is therefore possible to hypothesize and predict that the older adults in China benefit less cognitively from education.

In terms of adverse childhood experiences (ACEs), this study tried to include as many "same" experiences as possible, despite the inconsistency between the questionnaires related to childhood conditions. It is found that the Chinese older adults experienced higher percentages of early parental death, especially the death of mother --- 8.28% in comparison to 0.21% in the U.S. In terms of family SES, this study chose different criterion when dichotomizing father's education and father's job to make sure that the percentages were similar or close: no formal education in comparison to middle school; farming in comparison to manual-related jobs. Other than that, the Chinese sample specifically included the variable "childhood hunger" since they mostly experienced the Great Famine between 1959 and 1961. For family relations, findings revealed that both samples had worse relations with father before age 16, but the Chinese group reported much higher levels of parental abuse: harsh discipline was and is still the prevalent parental disciplinary technique in Chinese families (Xing, Zhang, Shao, & Wang, 2017). On average the females in Chinese sample experienced less parental loss, slightly higher levels of family SES, worse health, and better relations with parents; the U.S. sample shares similar results, except that the females seemed to have worse relations with both parents --- they were also more likely to be abused by parents.

For baseline cognitive functioning, although U.S. sample on average was more than 10 years older than the Chinese sample, they had higher levels of cognitive performance (22.84/35) than the Chinese counterparts (12.26/21). Meanwhile, considering the two domains of baseline cognitive functioning, the two samples showed similar patterns: the older adults generally performed better in mental health rather than in episodic memory section, indicating that they might suffer more from the memory-related problems rather than psychological issues.

For gender differences, it is found that in China, the males performed better than the females cognitively while the situation was opposite in U.S.: On average, the females in U.S. were enjoying higher levels of cognitive functioning. However, domain comparisons have also revealed that males in both samples scored higher in mental health but lower in episodic memory section. This is a little different from previous findings, that females would show advantages in verbal fluency, perceptual speed and mentor skills, while males would outperform in spatial, working memories and mathematical abilities (Sherwin, 200; Zaidi, 2010). The mixed results suggested that brain and cognitive features are modulated by environment, culture and practice, and these influences interact with the individual biological features (e.g. menstrual cycle, general hormone level) and current gender stereotypes in a way that has not yet been fully understood (Jancke, 2018).

4.3. ACEs and Mild Cognitive Impairment

For the associations between ACEs and mild cognitive impairment, there were some interesting findings. Firstly, the life course perspective was confirmed in both groups: certain adverse childhood experiences were found to significantly influence the risk of mild cognitive impairment in later life. Family SES, which was represented by father's education and father's job, and was found to be the significant predictor of late-life cognitive functioning for older adults both in U.S. and China. Meanwhile, the two samples also had different significant ACEs: the Chinese sample suffered more from peer relations (childhood loneliness), while the U.S. sample was more susceptible to family-related variables (early paternal death and abuse from parents). When cognitive functioning was divided into episodic memory and mental status, it is found that interpersonal relationships influenced both domains for the Chinese older adults. While for the U.S. sample, family relations had a greater impact on episodic memory, and family SES worked significantly for mental status.

Of course, gender differences have been detected across the two samples. For the male respondents in China, they were more susceptible to family SES and family relations --- especially variables related to mothers. On the other hand, ACEs that contributed to mild cognitive impairment for the U.S. males were individual childhood health, family SES, and relations with father, which is different from the Chinese peers. For the female respondents, U.S. and China samples shared some similarities --- both were significantly influenced by early paternal death and abuse from parents. However, the Chinese sample was also susceptible to childhood hunger and loneliness.

Overall, it is generally found and confirmed that childhood SES could significantly influence cognitive functioning in late life, and this is in accordance with previous literature (Wen & Gu, 2011; Zhang, Hayward, & Yu, 2016; Greenfield & Moorman, 2019). For the Chinese sample, interpersonal relationships were also as important: this fits the linked lives principle of the life course perspective; while for the U.S. sample, early paternal death was especially important. This study conjectures that since the death of father is a highly stressful life event both for the children and the mother, while the children at this time are in significant need of support, the inverse could happen because of changes in the family situation and family roles post bereavement. In some cases, the children's mother themselves would be struggling with their own grief and experiencing psychological difficulties (Bergman, Axberg, & Hanson, 2017). Different from China, where family members would live near each other and foster close relationship with the community, the U.S. families were usually more independent and private: Less linked lives. Therefore, the stress brought by losing father could be alleviated by other relatives, friends and caregivers in China, while the traumatic experiences might complicate the children's grieving process in U.S. when no one was there to help the child (Cohen, Mannarino, & Knudsen, 2004).

4.4. Adulthood Educational Attainment: Moderation Analysis

For both samples, adulthood educational attainment significantly moderated the detrimental effects of ACEs: Education buffered the effects of hunger for the Chinese sample, and the effects of early paternal death for the U.S. sample. And most importantly --- the moderation worked only for the females, but not the males. This confirmed the resource substitution theory as discussed, that education could improve the well-being more for women, because socioeconomic disadvantage made them depend more on education to achieve the well-being (Ross & Mirowsky, 2006). In the analysis, the dichotomized educational level for the Chinese sample was middle school or higher, and the criteria was high school or above for the U.S. sample. Although there were significant gender disparities in terms of educational level for the Chinese sample, as discussed above, there were no significant gender differences for the U.S. older adults, and the percentage was more than 80%. Still, it was found that the return from education was greater for people from disadvantaged backgrounds --- the female group (Brand & Xie, 2010). Moreover, females from disadvantaged backgrounds who obtained higher education credentials might be especially resilient (Schafer, Wilkinson, & Ferraro, 2013), and this might be another reason why they could find resources to make up for the trauma in childhood.

In addition, domain analysis of cognitive functioning revealed that adulthood educational attainment worked mostly on the episodic memory domain, but not mental status for both samples. This is new, since previous literature mostly focused on the psychological well-being of older adults and confirmed the association between education and adulthood psychological health. While in this study, there is evidence for a positive effect of education on memory performance, represented by immediate episodic memory and delayed episodic memory. Memory ability is particularly susceptible to normal aging (Luo & Craik, 2008; Tromp, Dufour, Lithfous, Pebayle, & Despres, 2015), and is often disproportionately implicated in the early stages of Alzheimer’s disease (Greene, Baddeley, & Hodges, 1996; Grober, Hall, Lipton, Zonderman, Resnick, & Kawas, 2008; Small, Fratiglioni, Viitanen, Winblad, & Backman, 2000). One mechanism of education’s moderation role might be through increasing the cognitive reserve, while higher levels of cognitive reserve could lead to better performance in memory, language, and speed of processing (Rentz et al., 2010). This might also explain why in both samples, the female respondents scored higher in episodic memory than their male counterparts, since they benefited more from education.

CHAPTER 5: Global Discussion

5.1 Review of Gaps in the Literature

As has discussed in the first chapter, researchers have investigated the relationship between childhood conditions and late-life cognitive function within the life course framework. While these studies have provided valuable contributions to the literature, there are several important and evident gaps when reviewing the study results. In particular, both childhood conditions and cognitive functioning have not been studied comprehensively: childhood conditions were usually specified as socioeconomic status, early parental death or loneliness, and seldom were these conditions included in one study together; moreover, cognitive function was usually taken as a whole, despite the fact that the assessment was made up of several domains. In addition, how adulthood educational attainment interacts with various childhood conditions in influencing cognitive outcome in late life remain veiled. Possible gender differences in terms of the above-mentioned focal relations are also needed to provide a comprehensive understanding of the resource substitution perspective. Furthermore, there is even less literature investigating whether these links are taking place over the globe or in specific countries. This study sought to address these limitations by adopting conceptual life course models to capture the complex relationships between adverse childhood experiences (ACEs), adulthood educational attainment, and late-life cognitive function.

5.2 Answers to the Research Questions

Research Question 1: Describe the general cognitive functioning conditions for older adults and discuss the disparities for older adults from different groups.

For question 1, this study found that for the Chinese older adults, they scored 12.26 out of 21 for the total cognitive functioning, and 1,968 (23.7%) of the respondents experienced mild cognitive functioning in the follow-up studies. Older adults in China performed better in mental status assessments than the episodic memory tests. As for the gender disparities, this study found that on average the males outperformed the females in both total cognitive functioning as well as mental health functioning, but they scored lower in episodic memory, indicating the sub-section differences.

For the older adults in the U.S., this study found that they had higher levels of baseline cognition (22.84/35), and only 1,282 (15.7%) experienced mild cognitive functioning in the follow-up studies, a percentage much lower than that of Chinese older adults. Similarly, the older adults scored higher in mental status assessments. However, when it comes to male/female differences, this study found that females in the U.S. sample scored higher in both total cognitive functioning and episodic memory, but lower in mental status.

Research Question 2: How are adverse childhood experiences (ACEs) associated with mild cognitive impairment of older adults? What about the two domains of cognitive functioning (episodic memory and mental status)?

To answer research question 2, this study carried out Cox proportional hazard models separately for each sample and each domain of cognitive functioning, while controlling for the demographic characteristics as well as individual health behaviors. For both samples, various ACEs were found to be significantly associated with risks of mild cognitive impairment in later life.

For the Chinese sample, findings revealed that family SES, represented by father's education, as well as interpersonal relations were significantly associated with risk of mild cognitive impairment in later life. Most other ACEs were also detrimental, while abuse from mother was protective. When cognitive functioning was divided into episodic memory and mental status, results showed that for episodic memory, only childhood interpersonal relationships, indicated by loneliness and relations with mother were significant predictors of impairment; for mental status, apart from family SES and interpersonal relationships, childhood hunger was also a strong risk factor for the Chinese older adults.

Results were a little different for the U.S. sample: childhood SES, represented by father's job, was significantly related to risk of mild cognitive impairment. Moreover, early paternal death was specifically significant, and the size of coefficient was also bigger: the influences extended to both sections of cognitive functioning, influencing both episodic memory impairment and mental status impairment. However, episodic memory was also susceptible to abuse from parents, while mental status was more impacted by family economic hardship.

Research Question 3: Does adulthood educational attainment to some extent influence the association between ACEs and late-life cognition? If so, what are the influences?

In this study, adulthood educational attainment was taken as a moderator to check if it could work as a positive resource and buffer the detrimental effects of ACEs. Interactions between education and ACEs were added in the models. Results showed that for the Chinese sample, there were no significant moderating effects for the risk of mild cognitive impairment and the risk of mental status impairment, but education significantly reduced the risk of episodic memory impairment by childhood hunger.

Meanwhile, education worked effectively for the U.S. sample: there were significant interactions between education and early paternal death, greatly reducing the risks of mild cognitive impairment and episodic memory impairment. For mental status impairment, there were only direct protective effects of education.

Research Question 4: Are there any gender differences in the above-mentioned associations?

Dividing both samples into male and female groups, gender differences have been detected. Among the Chinese older adults, results revealed that the only significant ACE was father's education for the male subsample in terms of mild cognitive impairment; meanwhile, they were more susceptible to mother-related variables, for instance early maternal death, poor relations with mother, and abuse from mother. While for the female subsample, they were influenced by a variety of ACEs: childhood SES, early paternal death, hunger, and interpersonal relations. The protective effects of adulthood educational attainment were also detected for various ACEs: hunger, loneliness and family SES, indicating that the females, despite at a disadvantaged position, could benefit more from education, which perfectly fit the resource substitution theory.

The resource substitution theory also worked for the U.S. older adults. Results showed that although males were influenced by ACEs such as family economic hardship, family relations and childhood death, there were no moderating effects of adulthood educational attainment; while for the females, early paternal death and abuse from parents were significantly increasing the hazards of mild cognitive impairment, and education reduced the effects of both ACEs. The similar moderation pattern took place for episodic memory, but not for mental status impairment.

Research Question 5: What are the similarities and differences between older adults from U.S. and China in terms of the above-mentioned associations?

This study found that the older adults in U.S. and China had both similarities and differences in the focal relationships. Firstly, and most importantly, both populations re-confirmed the life course theory that ACEs could have long-lasting effects on late-life cognitive functioning, and that adulthood educational attainment could moderate the detrimental effects of ACEs. Secondly, both samples also echoed the resource substitution theory, that females could benefit more from education in terms of well-being. Thirdly, some ACEs, for instance childhood family SES and relations with parents were significant for both samples, indicating that the influences of ACEs were not cultural-specific or regional-specific: It might be generalizable to a greater population.

Meanwhile, some differences have also been detected. For the Chinese sample, the significant family SES indicator was father's education, while the indicator was father's job for the U.S. sample. Moreover, the Chinese older adults were more susceptible to mother-related variables, while the U.S. sample was heavily impacted by early paternal death. Lastly, some country-specific ACEs have been detected: for instance, childhood hunger was a significant risk factor for the Chinese older adults.

5.3. Limitations and Strengths

In addition to afore-mentioned limitations in chapter 2 and 3, some limitations of this study should be discussed. The first primary limitation is related to one of the challenges of conducting life course epidemiology research, which is the varying definitions and measurements that complex exposures exhibit. Adverse childhood experiences, for instance, capture a wide array of traumas and experiences, and there has been no consensus as to which one to include in the wide definitions of ACEs. Despite the fact that this study has tried to include as many common ACEs as possible to facilitate comparison, some dataset-specific childhood variables, such as sibling experience and parent mental health in CHARLS and specific childhood illnesses such as muscles and heart diseases in HRS were not included. This limitation could also be applied to the definition of mild cognitive impairment: there has been no consensus on the definition, and choosing another criterion might lead to possible different results. The second limitation consists of the retrospective nature of the childhood conditions assessment. There might be some misclassification arising from more cognitively declined individuals having worst recall. A third, and perhaps most related limitation arises from the potential of selection bias arising from survivor bias. A large body of literature has reported robust associations between ACEs and premature mortality (Kelly -Irving et al., 2013; Rod et al., 2020), which would lead to them not likely being represented in our cohort of older adults aged 50+. If these individuals had worse late-life cognitive function and were more likely to experience mild cognitive impairment, then this would lead to an underestimate of the effects of ACEs, but this was not testable with the available data.

Despite these limitations, this study took advantage of several strengths. The research is strong in that first, it provided the variations in the late-life cognitive functioning for older adults from different social groups, to better identify the possible risk factors that influence mild cognitive impairment; second, tracing back to the childhood period, this study utilized the perspective life course to understand the processes through which childhood conditions influence cognition decades later while at the same time conceptualizing both as multidimensional factors, therefore also detecting what particular aspects of late-life cognition were especially sensitive to what childhood conditions, as well as which particular aspects of childhood conditions are more strongly and independently associated with late-life cognition. Third, guided by the idea of cumulative advantages/disadvantages, with attention to the role of adulthood educational attainment, this research also examined to what extent these adulthood factors might moderate or attenuate the focal relationships. Moreover, this study tested the gender differences in the focal relationships and reconfirmed the resource substitution theory. And lastly, this study utilized two nationally representative datasets to compare the conceptual models for U.S. and Chinese older adults, considering their different sociocultural backgrounds. It is believed that this study can provide inference for future research in an array of fields that can have implications for optimizing cognitive aging of global population.

5.4. Implications for Policy and Future Studies

This study has several important ramifications for population health, by highlighting the role of non-medical exposures and social dynamics in affecting health outcomes. One of the main goals of life course studies is to understand how social health inequalities arise from early life toxic exposures and how these exposures can affect biological, psychosocial and developmental outcomes. Results from this study has provided evidence to suggest that the discrepancies in late-life cognitive functioning may have roots in childhood and are a function of an array of complex social experiences and processes. This of course would draw specific attention to the childhood environment setting and how specific experiences, for instance the loss of father or loneliness could shape a person's health and life as they age. Given that the household and social environment are actually impossible or difficult to "treat" or be controlled within a medical setting, this study further provided support for the increasing efforts to address health via population health interventions as well as social policies that foster healthy household environments. On the academia level, longitudinal studies to better understand how ACEs alter brain structure and function and therefore contribute to psychosocial changes are needed. More precisely, future longitudinal studies would allow the valid identification of the influence of important variables including such as age of exposure, duration of the trauma, and type of abuse. Meanwhile, other important psychosocial resources, such as individual resilience should also be taken into consideration to foster a better understanding how some individuals are able to adjust after ACEs while others develop psychological or physical disorder.

Another public policy ramification that is a consequence of the results of this study centers around interventions that are implemented after the traumatic events in childhood. There was evidence to suggest the protective and moderating role of adulthood educational attainment on individual well-being. The consistent, durable relationship between education and health and the multitude mechanisms linking them suggested that programs targeting individual behaviors will have limited impact to counteract disparities. One potential solution may focus on universal state-level investment in the education of children early in the life course to disrupt the reproduction of social inequalities and change subsequent educational trajectories. Another important issue for both researchers and policymakers pertain to postsecondary enrollment and attrition, and their effects on health. Educational expansion in the college-for-all ear has yielded high post-secondary enrollment, but also unacceptable dropout rates with multiple detrimental consequences, including high rates of student debt and stigma (Link & Phelan, 2006). Under what circumstances college goers do reap health benefits, or how their postsecondary experiences can be modified to improve their health should be understood and studies.

For both of these educational avenues, effective implementation will need further research on the specific institutional characteristics and social contexts that shape the schooling effects. However, in designing interventions and policies, we need to be aware of the dual role of education as a drive and reproducer of inequality. Individuals from advantaged backgrounds may be better positioned to take advantage of new educational opportunities, and thus any interventions and programs need to ensure that marginalized populations have equal or greater access in order to avoid the unintended consequence of further intensifying disparities. In addition, researchers and policymakers should engage in a dialogue such that researchers effectively communicate their insights and recommendations to policymakers, and policymakers convey the needs and challenges of their practices to researchers.

Meanwhile, specific attention should be focused on females. Given that education could close the gender gaps in cognitive functioning, it is suggested that policies increasing educational levels especially for females who were in socioeconomic disadvantages, would be very important to improve individual human resources, expand opportunities to access health care services and reduce the risks of illness. Moreover, if education builds a general ability to discover means toward ends, then the pattern observed for gender differences in the effect of education on mild cognitive impairment should apply to other types of emotional and physical health and other socioeconomic disadvantages. Future research should continue exploring education's effect on other types of well-being --- like depression, anxiety, chronic conditions, and mortality --- as moderated by other kinds of socioeconomic disadvantages --- like poverty, recent immigration, ethnic minority status, and maybe neighborhood disadvantage. It is hoped that research will develop a body of findings that show how broadly the results of these analyses generalize, catalog the specific outcomes and disadvantaged statuses to which they apply, and specify the conditions under which they do or do not apply.

5.5. Conclusion

In summary, this study has adopted principles of life course perspective to investigate the related but distinct associations of adverse childhood experiences, adulthood educational attainment with late-life cognitive function. The results indicated that both ACEs and adulthood educational attainment were associated with risk of mild cognitive impairment in later life, and the moderating/benefiting effects of education especially significant for females in both Chinese and U.S. sample. This directed attention to the childhood window for understanding the early life etiologies of impaired late-life cognitive function. Furthermore, the results suggested that episodic memory might be the domain that is more largely affected by ACEs, which could provide insight into both the biological and sociological mechanisms of these associations. This paper could provide reference for future research in an array of fields that can have implications for optimizing cognitive aging.

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APPENDIX

Appendix A: Sample Characteristics of CHARLS Data Before Imputation

	Total (*N*=8,293)	Male (*N*=4,435)	Female (*N*=3,858)
Categorical Variables	**%**		
Male	53.48		
Rural	77.64	81.53	72.77***
Hukou: Agricultural	76.53	75.94	77.22
Married/Partnered	86.65	90.60	82.12***
Education:>=Middle School	30.35	38.35	21.15***
Smoking	44.30	74.63	9.41***
Drinking	34.41	54.68	11.12***
Poor Adulthood Health	74.99	72.83	77.37***
Early Maternal Death	8.28	8.66	7.85
Early Paternal Death	12.96	14.34	11.38***
Father: Illiteracy	60.79	60.84	60.74
Father: Farming	75.10	75.85	74.24*
Economic Hardship	38.59	39.71	37.30*
Hunger	75.29	77.46	72.78***
Loneliness	12.55	13.33	11.65*
Abuse from Mother	23.51	27.07	19.42***
Abuse from Father	16.71	23.10	9.50***
Poor Relations with Mother	17.42	18.92	15.70***
Poor Relations with Father	20.35	22.81	17.56***
Poor Childhood Physical Health	12.27	11.81	12.81*
Continuous Variables	**Mean**		
Age	62.35	62.60	62.07**
Social Engagement	1.24	1.25	1.22*
Baseline Cognition	12.26	12.76	11.69***
Episodic Memory	3.44	3.40	3.50**
Mental Status	8.82	9.36	8.19***

Notes: Chi-square tests and paired t-tests were carried out to compare gender group differences; $^{+}P<.10$; $*P<.05$; $**P<.01$; $***P<.001$.

Appendix B. Correlation Coefficients between Various Adverse Childhood Experiences (ACEs), CHARLS.

	Momea	Dadea	Dadedu	Dadjob	Ecohard	Hunger	Lonely	Rel_mom	Rel_dad	Abu_mom	Abu_dad	Health
Momea	1											
Dadea	.130	1										
Dadedu	.034	.067	1									
Dadjob	.000	-.134	.197	1								
Ecohard	.061	.122	.098	.036	1							
Hunger	.035	.043	.050	.092	.182	1						
Lonely	.103	.102	.034	.003	.121	.055	1					
Rel_mom	.019	.006	.030	.000	.035	.007	.032	1				
Rel_dad	.009	.025	.013	.003	.045	.018	.057	.489	1			
Abu_mom	-.009	-.000	.012	-.016	.062	.049	.052	.118	.073	1		
Abu_dad	.001	-.036	.012	.037	.051	.038	.052	.082	.144	.508	1	
Health	.030	.055	.017	-.003	.114	.053	.077	.010	.030	.037	.018	1

Notes: Momea=Early maternal death; Dadea=Early paternal death; Dadedu=Father being illiterate; Dadjob=Father's occupation as farming; Ecohard=Economic hardship; Rel_mom=Poor relations with mother; Rel_dad=Poor relations with father; Abu_mom=Abuse from mother; Abu_dad=Abuse from father; Health=Poor self-rated health.

Appendix C: Sample Characteristics of HRS Data Before Imputation

	Total (*N*=8,152)	Male (*N*=3,364)	Female (*N*=4,788)
Categorical Variables	**%**		
Male	41.27		
U.S.-Born	90.42	90.11	90.98
Married/Partnered	58.92	74.94	47.66***
Race			
White/Caucasian	84.07	85.37	83.15***
Black/African America	12.79	10.97	14.08***
Other	3.14	3.66	2.78***
Education:>=High School	82.59	82.94	82.35
Smoking	8.67	9.22	8.29*
Drinking	53.52	62.90	46.93***
Poor Adulthood Health	22.63	21.68	23.14*
Early Paternal Death	7.51	8.95	6.50***
Early Maternal Death	0.21	0.24	0.19
Father: <=Middle school	47.73	46.05	48.91*
Father: Manual	56.23	56.63	55.95
Economic Hardship	31.56	34.45	29.53***
Poor Relations with Mother	17.90	14.43	19.56***
Poor Relations with Father	24.77	24.17	24.98
Abuse from Parents	5.92	5.02	6.72**
Poor Childhood Physical Health	5.90	5.23	6.37*
Childhood Depression	1.73	1.34	2.01*
Continuous Variables	**Mean**		
Age	73.89	73.70	74.02
Social Engagement	5.67	6.57	5.85**
Baseline Cognition	22.84	22.56	23.04***
Word Recall	9.84	9.28	10.23***
Mental	13.00	13.28	12.81***

Notes: Chi-square tests and paired t-tests were carried out to compare gender group differences; ^{+}P< .10; *P< .05; **P< .01; ***P< .001.

Appendix D. Correlation Coefficients between Various Adverse Childhood Experiences (ACEs), HRS.

	Momea	Dadea	Dadedu	Dadjob	Ecohard	Rel_mom	Rel_dad	Abuse	Health	Depress
Momea	1									
Dadea	.129	1								
Dadedu	-.011	-.061	1							
Dadjob	-.003	-.057	278	1						
Ecohard	.015	.016	.109	.080	1					
Rel_mom	.056	.023	-.068	-.072	.056	1				
Rel_dad	.019	.022	-.063	-.061	.122	.432	1			
Abuse	-.001	.033	-.036	-.008	.081	.211	.278	1		
Health	.034	.011	.039	-.015	.093	.042	.046	.044	1	
Depress	.014	.015	-.014	-.015	.049	.115	.109	.134	.078	1

Notes: Momea=Early maternal death; Dadea=Early paternal death; Dadedu=Father being illiterate; Dadjob=Father's occupation as farming; Ecohard=Economic hardship; Rel_mom=Poor relations with mother; Rel_dad=Poor relations with father; Abuse= abuse from parents; Health=Poor self-rated health; Depress= Childhood depression.