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***The Impact of Cognitive Decline on Decision-making among Older
Persons in China***

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Health Care Management

Master of Public Health

Yale School of Public Health

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Abstract

Decision-making among the older population is of importance as older persons make critically consequential decisions on daily errands, household financials, and care-seeking that affect the remainder of their lives.¹ Despite the increasing prevalence rate of cognitive impairment in developing countries, many questions surrounding the impact of cognitive impairment on decision-making among older persons remain unexplored. Therefore, using data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), this study helps bridge the gap in the existing literature by examining the effect of cognitive decline on decision-making among the older population in China. We first investigate the association between an individual's cognitive ability and decision-making status on daily errands. The study results suggest that differences in the level of cognitive ability have a significant impact on individual's ability to make decisions on daily errands. Effects of cognitive decline on decision-making among older persons are more sizable among those who are currently single, went to school, have fewer children, and are experiencing poor health. In addition, we examine the relationship between individual's cognitive ability and financial decision-making within the household. We find that cognitive decline plays a major role in determining the responsibility of making personal and household financial decisions. More salient effects are found among elders who are single, went to school, have fewer children and siblings, and are in poor health status. Next, we study the association between changes in cognitive ability and preventive care-seeking patterns. Due to limited waves of data available, we do not observe any significant effects of cognitive decline on the use patterns of preventive care. In conclusion, our findings suggest that cognitive decline is associated with poor decisions made among those aged 65 or above, indicating the practical significance of cognition health among older Chinese adults.

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Introduction

Cognitive functioning refers to multiple mental abilities, including learning, thinking, reasoning, remembering, problem-solving, decision making, and attention, which is a well-known indicator of maintaining independence and survival in older adults.² With age being the greatest risk factor for cognitive impairment, older populations are more subject to the decline of cognitive functioning, which ranges from a mild form of cognitive decline to dementia.³ As a major cause of disability and dependency among older people, cognitive impairment is a neurological condition that mostly occurs in individuals aged 60 or older.⁴ Given the increased longevity and growing aging population, cognitive impairment including Alzheimer's Disease-Related Dementias (ADRDs) has become one of the most rapidly growing public health concerns in the 21st century. Deteriorating cognitive function will not only impact the lives of affected individuals and their caregivers but also inflict a heavy economic and fiscal burden on the healthcare system and societies as a whole.

As cognitive function generally declines with age among older adults, decision-making is critical in aging, when individuals make some of life's most influential decisions.⁵ Research conducted in the West has found that impaired cognitive function is associated with poor decision-making among older populations as decision making becomes an increasingly complex behavior – including choosing retirement benefits, health care, and health insurance – that requires higher-order cognitive functions.^{5,6,7} Studies of patients with dementia have found that patients experience losses in their ability to make decisions, often making less optimal decisions than healthy aging peers.⁸ More importantly, older persons who exhibit cognitive decline but do not yet meet accepted criteria for MCI or dementia are also subject to poor decision making. For example, McArdle and Woodcock observed poorer decision making and increased susceptibility to scams in old age as

consequences of cognitive decline even among persons without dementia.⁹ In addition, financial and health planning at older ages has become increasingly challenging as evolving policy reforms create more complex structures and choices for older persons, which largely impacts older adults and their quality of life, especially among those with cognitive impairment.¹⁰ Prior studies also indicate the linkage between cognitive function and financial decision-making. A study has shown that elders with MCI often make poorer decisions concerning financial and healthcare matters compared with their healthy counterparts, which is impacted by the severity and type of cognitive impairment.¹¹ Another longitudinal study has also detected that individual's cognitive function such as numerical ability is strongly associated with the financial outcomes of the family, suggesting declining financial skills among patients with MCI.¹² More importantly, a 3-year study investigating the medical decision-making capacity in MCI observed that MCI patients show a progressive decline in the ability to understand consent information in the medical setting.¹³ Therefore, recent contributions in Western literature indicate a significant role of cognitive function in decision-making among elders.

However, little attention has ever been paid to the aging population in developing countries, in which elders are more subject to the economic and health burden resulting from the escalating prevalence rate of cognitive impairment. In China, the growing aging population and increasing rate of prevalence can cause tremendous challenges to individual families as well as societies as a whole. Given the rapid economic growth and health insurance expansion, the population aged 60 years and over in China is expected to reach 30% by 2030.¹⁴ A recent meta-analysis studying the Chinese population found a prevalence rate of 14.7% for Chinese populations with MCI and pooled prevalence rates of dementia for those aged 55 years and older were estimated to be 4.03%.¹⁵ With continued population aging and increased expected longevity, many expect the rate of the

older population with cognitive decline and impairment to continue to rise in China. More importantly, with only 26.9% of patients with dementia being diagnosed currently in China, increased health awareness and advanced health care systems may expedite the increasing detection of cognitive impairment.¹⁶ Therefore, home to the largest aging population and patients with dementia, cognitive decline and impairment are no doubt costly for the Chinese as individuals with ADRDs use more care and incur higher expenditures than people without cognitive disorders.¹⁷ Previous studies in the U.S. also reported that patients with poor cognitive status were more likely to use nursing and home care services whereas less likely to use outpatient services with lower annual household income but higher medical expenditures.¹⁸ As a result, the estimated total annual costs of dementia in China increased from US\$ 0.9 billion in 1990 to US\$ 47.2 billion in 2010 and were predicted to reach US\$ 114.2 billion in 2030.¹⁹ As mentioned above, except for the medical expenditures and costs from loss of productivity, financial losses may also play a role in the enlarging burden because older populations are known to hold the majority of household wealth but with declining ability to make proper financial decisions. Recent research among older American couples also found that financial decision-makers with cognitive decline experience significant reductions in their household wealth.²⁰ Therefore, additional empirical evidence on how cognitive decline affects decisions made by older persons is critical under the context of increased economic and health burden in China, which may also bring important implications for China's ongoing health reforms.

Existing research simply examines the relationship between cognitive decline and decision-making in most developed Western countries such as the U.S. and UK, whereas limited research focuses on the heterogeneous effects across different groups and little attention has been paid to developing countries like China. Given the significant role cognitive function plays in the

elder's decision-making process, understanding how older populations with cognitive decline make decisions is critical to inform policy-making in developing countries, which have limited resources and a growing aging population at risk. More importantly, numerous studies have found differences in the values and behavior of people from different national cultures and policy systems.^{21,22} As Easterners advocate collectivism, self-sacrifice, and filial piety as in the traditional Chinese culture and Confucian philosophy, most Chinese elderly with dementia were receiving home care from family members.²² The importance of social and family obligations in the Chinese culture results in filial piety being a strong family norm, especially in most rural areas. Children in eastern cultures are expected to provide material and physical support, and live with their older parents, which indicates that living arrangement and household composition may generate differences in how cognitive decline influences the decision-making patterns among older persons in China as compared to older adults in the U.S.²³ For example, previous research studying the sample of Chinese elderly observed better mental health among those elders who receive higher financial support from their non-co-resident children.²⁴ Evidence from a longitudinal survey also observed that Chinese elders cared for by daughters have a lower probability of declining cognitive capacity compared with those who cared for by their sons.²⁵ This indicates that a further investigation of the Chinese sample may bring additional insights to the general trends found in most American samples. Additional research has also shown that Asian people emphasize family involvement in medical decision-making and observed higher patient desire for family involvement in patient-physician communication in the Chinese and South Korea patients, which may also cause a discrepancy in the effects of cognitive decline on elders' health care seeking pattern compared with western findings.²⁶ Therefore, with culture being an important facet of the decision-making process, a study of the Chinese sample would provide highlights for Eastern

countries on health policy design to alleviate the impact of poor cognitive health on decision-making among elders.

More importantly, recent social policy reforms in China add a layer of significance to a better understanding of decision-making among elders. As the New Rural Pension Scheme (NRPS) was introduced in 2009 to cover rural elderly in China, most rural elders with lower education and lower-income groups are able to enroll and benefit from this new social scheme.²⁷ However, while this large social pension program was designed to provide financial protection for the rural population, suboptimal enrollment such as failure to switch to the highly subsidized NRPS was found common in the older cohort.²⁸ Chances are elders with cognitive decline may experience decline in making optimal personal and financial decisions for themselves and their families as well, thus leaving money on the table. More importantly, as the evolving pension and health system reforms challenge the aging population in China, findings like these may indicate that certain groups with cognitive decline may be disproportionately subject to those policy changes and make suboptimal decisions, failing to receive the given benefits. For example, according to estimates from a Chinese regional study conducted in several mega-cities, nearly 96% of the patients with cognitive impairment are cared at home and significant differences were seen in rural versus urban areas.²³ Understanding of the heterogeneity in the impact of cognitive decline on decision-making can inform further improvement of current health plans and pension programs in China.

More importantly, as children historically play more critical roles in providing old-age support in China, the nationwide one-child policy implemented from 1979 to 2015 in China may exacerbate the family burden given the increased longevity and cost of caregiving for elders with cognitive impairment.^{29,30} With most of the community-based services in China being in the early stages of development, the impact of cognitive decline on decision-making among the aging

population poses a large threat to families and the health care system in China. Therefore, as the Chinese government is devoted to meeting escalating health care needs as demographic shifts and socioeconomic changes, what role cognitive decline plays in the decision-making process among the aging population provides valuable information on health resources allocation and future policy design with China's evolving long-term care landscape.³¹ For example, how will elders with cognitive decline make decisions on daily errands (e.g. living arrangements, social activities)? On the other hand, if differences in the level of cognitive ability play a major role in determining who is the household decision-maker? And will cognitive decline change how elders make decisions on preventive care? More importantly, how moderating factors such as education, family structure, and living arrangements help protect against the impact of cognitive decline on poor decision-making? These questions on the impact of cognitive decline on decision-making have important implications for policy-making, particularly in developing countries like China with strong traditions of elders being the major household decision-makers and wealth-holders.

To date, there is no study in China examining whether cognitive decline predicts decision-making on daily errands and household financials in China. Older persons who exhibit cognitive decline but do not yet meet accepted criteria for MCI or ADRDs may benefit from early intervention, which offers a unique opportunity to reduce the public health burden posed by cognitive decline and impairment. Therefore, this study helps bridge the gap in the existing literature and provide guidelines on health policy design in China by exploring the impacts of cognitive decline on personal and household decision-making.

Research Questions

In light of this gap in the current literature, we use data from the CLHLS to investigate the impact of cognitive decline on decision-making among the older population in China. The wealth of information available in the CLHLS, spanning cognition, individual self-reported health, household composition, and living arrangement allows us to examine this relationship comprehensively and to evaluate multiple mediating factors that may moderate the impact. In this paper, we address three specific research questions:

- 1) Does cognitive decline affect decision-making on daily errands and, if so, how does education, family structure, and living arrangement moderate the impact of cognitive decline on the pattern of decision-making?
- 2) Does cognitive decline affect individual's financial responsibility within the household and, if so, does education, family structure, and living arrangement moderate the impact of cognitive decline on the pattern of financial decision-making?
- 3) Does cognitive decline affect individual's preventive care-seeking patterns and, if so, how does education, family structure, and living arrangement moderate the impact of cognitive decline on the pattern of care-seeking?

Methods

Data source

We conduct a secondary data analysis using the CLHLS. With a focus on healthy longevity and a simultaneous consideration of various risk factors, the CLHLS interview the oldest-old aged 80 and older from 22 provinces in mainland China and started to include those young elders aged 65-79 as a comparison since 2002. Covering approximately 85% of the Chinese population, core CLHLS questionnaires include information on cognitive function, health outcomes, and socio-demography across different variables such as living arrangements, household composition, and lifestyle-related behaviors through its large population size. The longitudinal dimension of the CLHLS allows us to study how changes in cognitive ability over time affect an individual's decision-making ability and pattern on daily errands, household financials, and preventive care-seeking.

Participants are randomly selected in half of the total number of counties and cities in the 22 provinces with replacements for deceased elders. The baseline survey was conducted in 1998 with 9,093 participants and new participants are enrolled during the follow-up to reduce the attrition due to death and loss to follow-up. Until present, the CLHLS has conducted seven waves (1998, 2000, 2002, 2005, 2008-2009, 2011-2012, and 2014) of face-to-face interviews using internationally compatible questionnaires. An enumerator and a nurse or a medical school student conducted the interview and performed a basic health examination at each interviewee's home. As far as the proxy is concerned, proxy respondents are allowed for general informational questions but not applicable to the test of cognitive function, which is required to be answered by participants themselves. The CLHLS data are collected by Peking University's Center for Healthy Aging and

Family Studies and the China National Research Center on Aging, with support from the U.S. National Institute on Aging.

Participants/Sample

Information in CLHLS is based on self-reports. This paper is based on all seven waves of data including information on cognitive function, current health status and quality of life, ADL, living arrangement, and socio-demographic statuses such as age, education, residence type, and household composition. For analysis purposes, we restrict our attention to participants without cognitive impairment (i.e. MMSE score < 24) at baseline with a sign of developing an MCI or dementia between 1998 and 2014 as this study aims to measure the decline of cognitive status in the same individual for more rigorous comparisons. Therefore, individual-time observations after the participants experienced cognitive impairment are also excluded as they are not comparable. In addition, we also exclude participants who maintain good cognitive health without cognitive impairment throughout all available waves and those who only completed one wave of the Mini-Mental Status Examination (MMSE). The cleaned dataset consists of 7,031 persons and 19,704 person waves (**Figure 1**).

Variables

Independent variable

The independent variable of interest is cognitive decline, which was measured for all seven waves (1998, 2000, 2002, 2005, 2008-2009, 2011-2012, and 2014). The CLHLS measures cognitive function using MMSE, which consists of five major domains of cognitive function: orientation, registration, calculation, recall, and language. MMSE data is recorded as missing and

excluded from the data analysis if participants missed all answers of the MMSE. Participants are given 1 point (correct), 0.5 point (missing) or no point (wrong & unable to answer) for each question. For the question of naming foods, participants are given 1 point for each food named and 7 points for those who named 7 or more foods. A total of 24 questions are included with a total possible score of 30. Lower scores indicate poor cognitive ability. For analysis purposes, binary variables are created to indicate the status of an individual's cognitive function in the given wave. A cut-off point of 24 is applied to classify subjects based upon MMSE scores according to the most relevant literature.^{32, 33} Individuals with a score of lower than 24 are coded as 1 on MCI with all others coded 0. All questions are answered by sampled elders themselves without proxy allowed. If the sampled elder had difficulty answering the cognitive function questions, the interviewer is required to record the reason for the inability to answer. Therefore, this study also included those who are unable to answer the MMSE because of the cognitive function as having MCI (MCI=1). Individuals are identified to experience cognitive decline if their MCI status changed from 0 to 1 within the seven waves. For more rigorous comparison, we also exclude observations after the individual experienced a cognitive decline (from 1 to 1) as well as those who recovered from MCI (from 1 to 0).

Outcome variables

1. Decision-making on daily errands

Decision-making on daily errands is one of our three major outcome variables. We assess subjects' decision-making ability through the survey question: "Can you make your own decisions concerning your daily errands?" This variable is measured for all seven waves (1998, 2000, 2002, 2005, 2008-2009, 2011-2012, and 2014). For analysis purposes, an individual is given 4 points (always), 3 points (often), 2 points (sometimes), 1 point (seldom) or no point (never & not able to

answer) for this question. Lower scores indicate poor decision-making status as we assess the issue of whether and how does cognitive decline affect individual's decision-making ability on daily affairs. Binary variables are then created using a median split to indicate that individuals can often make decisions on daily errands for the purpose of describing sample characteristics.

2. Financial decision-making within the household

Responsibility of making financial decision decisions is measured through four waves (2005, 2008-2009, 2011-2012, and 2014). We measure individual's financial decision-making within the household through the survey question: "Please tell me your status of decision making on financial spending in your household." The question provides four options, which include a) make decisions on almost all spending in my household, b) make decisions on my own spending and a small amount of other spending in my household, c) make decisions only on my own spending, d) can't make decisions on any spending, and e) don't know. For analysis purposes, we create a dummy variable, which is coded as 1 if an individual can make at least some financial decisions within the household and coded as 0 if the individual can't make any decisions on the personal and household spending. Lower scores indicate poor decision-making status as we assess the issue of whether and how an individual's cognitive ability is related to financial responsibility within the household.

3. Health care-seeking pattern

We further examine the relationship between cognitive decline and decision making through the assessment of care-seeking patterns among older persons using data from two most recent waves (2011, 2014) as health care decisions and quality of decisions are critical to older individuals and their caregivers. This study primarily focuses on preventive care-seeking patterns because older persons are subject to greater health risks and preventive care has been proven to be

cost-efficient in reducing risk factors and care-seeking costs, which also indicates an appropriate financial decision to make. The measurement is based on the survey question: “Do you have regular physical examination once every year?”

Covariates:

We include a group of covariates with the potential to affect decision-making, which are tested using bivariate analyses. First, socio-demographic variables such as residential category (1=Urban, 0=Rural) and living arrangement (1=Living with someone else, 0=Alone) are included. In addition, we measure self-reported health status according to a five-category survey question, “How do you rate your health/quality of life at present?” and code a dummy poor health indicator as 1 if the respondent reports “bad” or “very bad” and 0 otherwise. Additional potential covariates such as quality of life, residential area, and marital status are also included. More importantly, core questionnaires also provide information on health outcomes and functioning, which includes ADL, IADL, and functional limitations. For analysis purposes, the study mainly focuses on data that involves the decision-making process.

Data Analysis Plan and Software to be Used

Descriptive statistics:

Descriptive statistics of the study population, including means, standard deviations, and percentages, are reported as appropriate for the study measures. STATA SE version 14.1 (Stata Corp, College Station, TX) is used to perform the analyses.

Statistical analysis:

To examine how cognitive decline is associated with multiple decision-making measures, we employ linear fixed-effects models using variables defined as above, adjusting for potential

confounders including other factors that might influence the correlations. In order to explicitly account for unobservable, invariant individual characteristics driving the change in individual's decision-making, we rely on the fixed-effects model and within-individual variation in decision-making ability and cognitive status to estimate the parameters of interest.²⁰ The estimation equations are specified as follow:

$$(1) \textit{Decision}_{it} = \alpha + \beta_1 \cdot \textit{MCI}_{it} + \gamma X'_{it} + t + \eta_i + \varepsilon_{it}$$

where t denotes time (wave) and i denotes individual i . $\textit{Decision}_{it}$ is an indicator of outcome variables. As stated above, we use three different cognitive variables (i.e. whether the individual has the ability to make decisions concerning daily errands, household financial responsibility, and preventive care-seeking patterns), which are all standardized and separately included in the regression equation. The main variable of interest is \textit{MCI}_{it} , which measures an individual's cognitive ability during the certain observation period; X'_{it} is a set of observed characteristics of the individual and household that may be correlated with both cognitive decline and the decision-making ability including health status, living arrangement, residential category, and etc. β_1 is our main parameter of interest that denotes the impact of cognitive decline on decision-making function and pattern. We also include a time fixed effect as denoted by t and feature the probability of the outcome variables to be affected by time-invariant personal characteristics as denoted by η_i ; and ε_{it} is the error term.

To describe how the does this pattern of decision-making changes across different covariates, stratified estimations are implemented to further explore the true relationship between cognitive decline and decision making by dividing the sample into several strata and identifying effect size across different strata. We estimate separately by gender, education, marital status, household structure, living arrangement, and health status following the fixed effects linear

probability model specification constructed above to examine the unobserved heterogeneity of the association between decision-making and cognitive decline across different moderating factors.

Results

Description of the sample

Table 1 shows the distribution of time-invariant characteristics among sample respondents including gender, education, occupation, and household structure. The selected sample has 59% female respondents and 41% male respondents. The majority of the respondents haven't received any education (64%) and were industrial or service workers (60%) before retirement. Among the respondents, 67% have at least 4 children and 61% have at least 3 siblings, which reflect the skewed distribution of household structure among older populations in China. The overall mean age of the study sample is 87.06 years (SD 9.40).

About 50% of the sampled individuals are observed for at least 3 waves. **Table 2A** shows the sample characteristics of person waves before and at MCI with regard to decision-making on daily errands. Compared with individual observations before MCI (62%), those at MCI show a lower percentage of individuals with good decision-making ability on daily errands (37%). Among different age groups, those aged 86 or above see a larger percentage decrease in the proportion of individuals that can make appropriate decisions on daily errands compared with that of their younger counterparts, which indicates the possibility that respondents aged 86 or above are more likely to be affected by cognitive decline. In addition, those who are males, living with someone else, and went to school experience a larger rate of decrease in the percentage of individuals with better decision-making ability. This also reflects those demographic groups are relatively more subject to the impact of cognitive decline on their decision-making abilities. As far as the health

status is concerned, the percentage of individuals that can make appropriate decisions among those having some difficulties with activities of daily living (ADL) and with poor self-reported quality of life and health status is significantly lower after having experienced MCI compared with that of their healthy counterparts. Differences in decreasing trends suggest that those with good health status are more likely to maintain good decision-making ability after experiencing cognitive decline. With regard to the financial measures, the decision-making ability of individuals who receive support from retirement wage is more likely to be affected by a decline in cognitive function. **Table 2B** shows the sample characteristics of person waves before and at MCI with regard to decision-making on household financials. Surprisingly, we do not observe very similar patterns as shown in **Table 2A**. Compared with individual observations before MCI (38%), those at MCI only indicate a slightly lower percentage of individuals that are able to make sufficient decisions on financials (34%). No significant differences across group proportions are found between individual observations before and at MCI in terms of decision-making on household financials except for those with poor health status. Individual observations with poor self-reported quality of life and health status see a larger percentage drop in the proportion of observations with ability to make sufficient decisions on household financials compared with that of their healthy counterparts, which indicates the possibility that individuals in poor health are more likely to be affected by cognitive decline.

Objective 1: The impact of cognitive decline on decision-making ability

In **Table 3**, we present regressions estimating the relationship between cognitive decline and decision-making on daily errands while adjusting for observable confounding factors. The model captures a negative relationship between cognitive decline and individual's decision-making

ability on daily errands. The estimated coefficients indicate that when cognitively healthy individual experiences cognitive decline to have MCI, the ability to make decisions on daily errands decreases by 10.4 percentage points ($P < 0.01$).

Looking at the results from the heterogeneous models, we observe that there is a heterogeneity across different socio-demographic groups in the association between cognitive decline and decision-making. All point estimates are statistically significant at 1% level. Conditional on age, education, occupation, health status, living arrangement and household structure, a one standard deviation increase in one's cognitive status is associated with a more pronounced decrease in individual's decision-making ability on daily errands among male respondents (12.4 percentage points) than among female respondents (9.1 percentage points). The breakdown by education level also reveals an interesting pattern – the relative influence of individual's deteriorating cognitive status on one's ability of making decisions on daily errands is less strong for those who never went to school. One possible explanation for this finding is that people with higher education may be more aware of their cognitive status, combined with the fact that the Chinese culture values shared decisions, leading to a larger role of decision-making on daily errands among older persons who went to school after they experienced cognitive decline.

Difference by marital status is also robust to fixed-effects estimation. Deteriorating cognitive function from normal to MCI produces a more sizeable effect on the elders who are currently single. Elders who live with someone else are more subject to the impact of cognitive decline on their decision-making, which may add value to conflicting findings in studies conducted in American couples. Investigation on the breakdown by health status also shows significant heterogeneity in the association between cognitive decline and decision-making. Self-reported health measures suggest that individuals who report poor health status (-15.0%) experience a more

striking negative effect on their decision-making ability compared with those who remain good health (-7.9%) after undergoing cognitive decline. The decision-making ability of individuals with at least one ADL (-10.0%) is also reported to be more likely affected by the deteriorating cognitive status than those without ADL (-8.9%).

More importantly, with a strong emphasis on family in Chinese culture, we further investigate the moderating effect of household structure on the relationship between cognitive decline and decision-making. Our findings suggest a larger impact on elders with fewer children and more siblings. Cognitive function deteriorating from normal to MCI decreases the ability to make proper decisions on daily errands by 11.1 percentage points among those with 0-3 children and by 9.2 percentage points among those with more than 3 children. On the contrary, a more sizeable effect is found among those with more than 2 siblings (-10.6%) compared with older adults who have 0- 2 siblings (-8.6%). This converse pattern may be caused by the fact that elders are more likely to live with and receive support from their children instead of siblings.

Objective 2: The impact of cognitive decline on financial decision-making

Table 4 summarizes results from the linear fixed effects model on the association between cognitive decline and financial decision-making within individual households, which provide similar results as found in objective 1 but attenuated effects were found on financial decision-making compared with those on making personal decisions. Increasingly poor cognitive states were found to be associated with a higher likelihood of making poor and less efficient financial decisions within the household. The estimated coefficients indicate that when cognitively healthy individual experiences cognitive decline to have MCI, the ability to make financial decisions within his/her household decreases by 10.2 percentage points ($P < 0.01$).

Heterogeneity is found as well across different socio-demographic groups in the association between cognitive decline and decision-making on household and individual financials. All point estimates are statistically significant at 1% level. After fully adjusting for demographic characteristics and health status, our model finds that male respondents (-11.1%) are found to experience slightly stronger effects on household financial decision-making as a result of cognitive decline compared with their female counterparts (-9.6%). The difference across education levels reveals that individuals who went to school (-11.7%) experience a slightly more striking negative effect on their decision-making ability compared with those who never received education (-9.7%) after undergoing cognitive decline. Smaller differences in effects on making financial decisions within households across groups compared with that on making personal decisions are likely driven by the fact that more educated individuals tend to be in charge of the household's finances. Therefore, while cognitive decline creates larger barriers to making proper financial decisions for the educated groups as they are more aware of their cognitive status.

Investigation on the breakdown by co-residence presents a more salient negative effect on those who live with someone else. Our model suggests that a one standard deviation increase in one's cognitive status is associated with a more pronounced decrease in financial decision-making ability within household among those who live with someone else (10.7 percentage points) than among those who live alone (6.9 percentage points). This is likely driven by the fact that those who live alone may be the only person responsible for household financial decisions, thus resulting in less salient effects even though they have experienced cognitive decline. In addition, we find similar patterns across marital and health status – deteriorating cognitive function from normal to MCI produces a more sizeable effect on financial decision-making among the elders who are currently single and reporting poor health status. Self-reported health measures suggest that

individuals who report poor health status (-10.1%) experience a more striking negative effect on their decision-making ability compared with those who remain good health (-9.8%) after undergoing cognitive decline. The decision-making ability of individuals with at least one ADL (-20.6%) is also reported to be more likely affected by the deteriorating cognitive status than those without ADL (-7.4%).

Further investigation of household structure presents similar moderating effects on the association between cognitive decline and financial decision-making. Our findings suggest a larger impact on elders with less children and siblings. Cognitive function deteriorating from normal to MCI decreases the ability to make decisions on household and personal financials by 11.0 percentage points among those with 0-3 children and by 9.4 percentage points among those with more than 3 children. Furthermore, a more sizeable effect is found among those with 0-2 siblings (-11.1%) compared with older adults who have more than 2 siblings (-7.7%). Thus, estimated coefficients from these two observations reinforce the fact that cognitive decline plays a relatively larger role in individual's ability to make proper financial decisions for elders with smaller households due to limited support from their intimate family members, which is compatible with Chinese traditional values that emphasize family support for older adults.

Objective 3: The impact of cognitive decline on preventive care-seeking

As can be seen in **Table 5**, we do not observe any evidence of a significant impact on preventive care-seeking patterns following a worsening in cognition. We note that the individuals are less likely to seek preventive care when cognitive decline occurs, yet estimates are not statistically significant. Heterogeneity is found across different socio-demographic groups – elders who went to school, have fewer children and siblings, and with poor self-report health status are

more subject to the negative effects following cognitive decline, although the differences are as well statistically insignificant. This is surprising since cognitive decline is expected to have a significant impact on care-seeking patterns as previous findings in the U.S. show that participants with MCI and dementia incurred significantly higher Medicare expenditures than healthy peers, even before they received a formal diagnosis.³⁴

Discussion

As cognitive impairment brings significant burden to individual families and society with one-child policy and enlarging aging population in China, how is cognitive decline correlated with decision-making remains unclear. The purpose of this analysis is to describe the relationship between cognitive decline and decision-making among older adults. Specifically, we investigate the extent to which cognitive decline affects decision-making from three different perspectives. We also compare the effect of cognitive decline across different socio-demographic groups to assess the moderating effects of interested covariates including gender, education level, marital status, household structure, living arrangement, and health status.

Carrying out this analysis in a sample drawn from the CLHLS, we find that individual's cognitive functioning does play a role in older persons' decision-making. As we account for individual time-invariant characteristics in fixed-effects regression, our findings suggest that elders with cognitive decline are likely to experience deteriorating decision-making ability with regard to daily errands as well as more important household financial matters. Such a result is consistent with previous findings in the U.S. that elders suffering cognitive aging and impairment experience, even those without dementia, often make poor decisions and selectively vulnerable to scams.⁹

In addition, the role of certain socio-demographic factors in the association between cognitive decline and decision-making is also found to be notable. Relative to peers in the sample, male respondents who are currently single, went to school, have fewer children, and are experiencing poor health are more subject to the consequence of cognitive impairment. This heterogeneity across different socio-demographic groups in our sample is comparable to other reports. Although our study is not designed to analyze causality, it seems that these factors bring about a more salient effect among older adults. More importantly, our findings somewhat confirm the hypothesis that for Easterners in China who value more about filial piety and family support, the number of children makes a difference in the effect of cognitive impairment on decision-making including both personal and financial decisions. Negative effects of cognitive decline on both personal and financial decision-making are notably more pronounced if the elder has fewer children. Our further investigation on the moderating effect of living arrangement also introduces an interesting diversion from Western literature, providing additional insight for conflicting views in Western samples. For example, a cohort study among dementia patients finds that individual living alone is lack of awareness of cognitive impairment and thus is subject to heighten the risks for adverse outcomes.³⁵ However, a two-year study conducted in American couples also suggests that people who live alone engage in more social activity than those living with others, and are found to be at no greater risk of a decline in cognitive scores.³⁶ Our analysis reveals that those who live with someone else are more likely to experience decline in decision-making after developing MCI, which raises questions about whether family support can help alleviate the negative effect of cognitive impairment as expected.

As far as medical decision-making is concerned, we find no evidence that preventive care-seeking pattern is associated with a decline in cognitive ability. While we fail to reveal an effect

between cognitive status and medical decision-making as found in previous Western studies, this may indicate a good signal that cognitive impairment does not prevent those elders in China from making appropriate decisions on health care. More research is also encouraged as the data on preventive care-seeking is somewhat limited compared to other decision-making measures, which reduces the power of the study and gives less meaningful results.

As persons with MCI are confronted with risks of decline in a variety of decision-making, consequences of MCI at the family and society level are also detrimental. For vulnerable populations such as those elders living in the rural area, progressive and largely irreversible declines in cognitive functioning pose enormous risks and losses as they experience decline in decision-making ability. By investigating the association between cognitive impairment and decision-making, our study highlights the potential benefit of proper intervention and early preparation for the loss of functional capacities (e.g. by seeking support from family members and community services). Our further investigation of sources of heterogeneity shaping impact on decision-making and potential mechanisms provides a more holistic view of how different groups are disproportionately affected by the cognitive impairment, which is critical to future policy design of social security and health policy programs in China. Our findings suggest the need for appropriate social and health resources allocation as certain groups such as those with less children are more subject to welfare losses due to a decline in decision-making following cognitive impairment.

Our study has a major strength and several limitations. The strength of this study is that we use a large and diverse national sample, which covered 7,031 participants and 19,704 person waves spanning all seven available waves from 1998 to 2014. But the findings should be considered with certain limitations in mind. First, the data structure does not allow us to identify the exact timepoint

of MCI initiation, which may introduce potential errors to our current findings. In addition, the observed changes in decision-making following the development of the MCI can be attributed to the cognitive decline itself only to the extent that variables driving differences between individuals who experience a cognitive decline and individuals who do not are accounted for. While individual- and household- level variables are controlled in our model, there is a possibility that unobservable characteristics across groups may lead to differentiated effects on decision-making. Therefore, our estimation strategy only allows us to examine the correlations instead of the causation between cognitive decline and decision-making. However, as we were able to prospectively analyze the impact of earlier cognitive change on later decision making, the model supports the predicted direction of cognition impacting decision making.

Conclusion

This study adds important insights on the role of cognitive decline in decision-making, which may help policymakers design future policies including health resources allocation and financing policies for social security programs in China. In response to the population aging and enlarged disease burden due to the rising life expectancy, the Chinese government has actively promoted the prevention and treatment of chronic non-communicable diseases to diagnose diseases in the early stage and advocated a healthy lifestyle under the national Healthy China Initiative.³⁷ As the ongoing health system reforms roll out nationwide to improve availability and accessibility of health services through the establishment of a hierarchical medical system, our study deepens the understanding of the association between cognitive decline and deteriorating decision-making, which indicate the potential health and economic burden and household financial losses. Our findings show that decline in decision-making is a common consequence following the

initiation of MCI, which highlights an important role of cognitive decline in the Chinese population, especially for elderly with existing poor health conditions and less support from their children.

More importantly, the negative correlations we find between cognitive decline and decision-making suggest the need for policymakers to revisit the importance of early prevention and treatment for cognitive impairment. If older adults are found to experience significant losses in the ability of decision-making in the meanwhile of developing MCI, the Chinese government should evaluate current social and community resources to best match people's needs as we explore the heterogeneity across different groups. Our findings also offer Chinese policymakers insights on the design of financing policies and reimbursement mechanisms for health plans and pension programs as elders experience a decline in decision-making.

In summary, as cognitive disorder becomes one of the most important public health issues in both China and the globe, more research is needed to investigate the identify the associated consequences following cognitive decline among older persons, which has the potential to alleviate the caregiver burden and facilitate interventions to improve decision-making, ensuring safe, affordable and high-quality care to elders in need.

Figures and tables

Figure 1. Consort Diagram

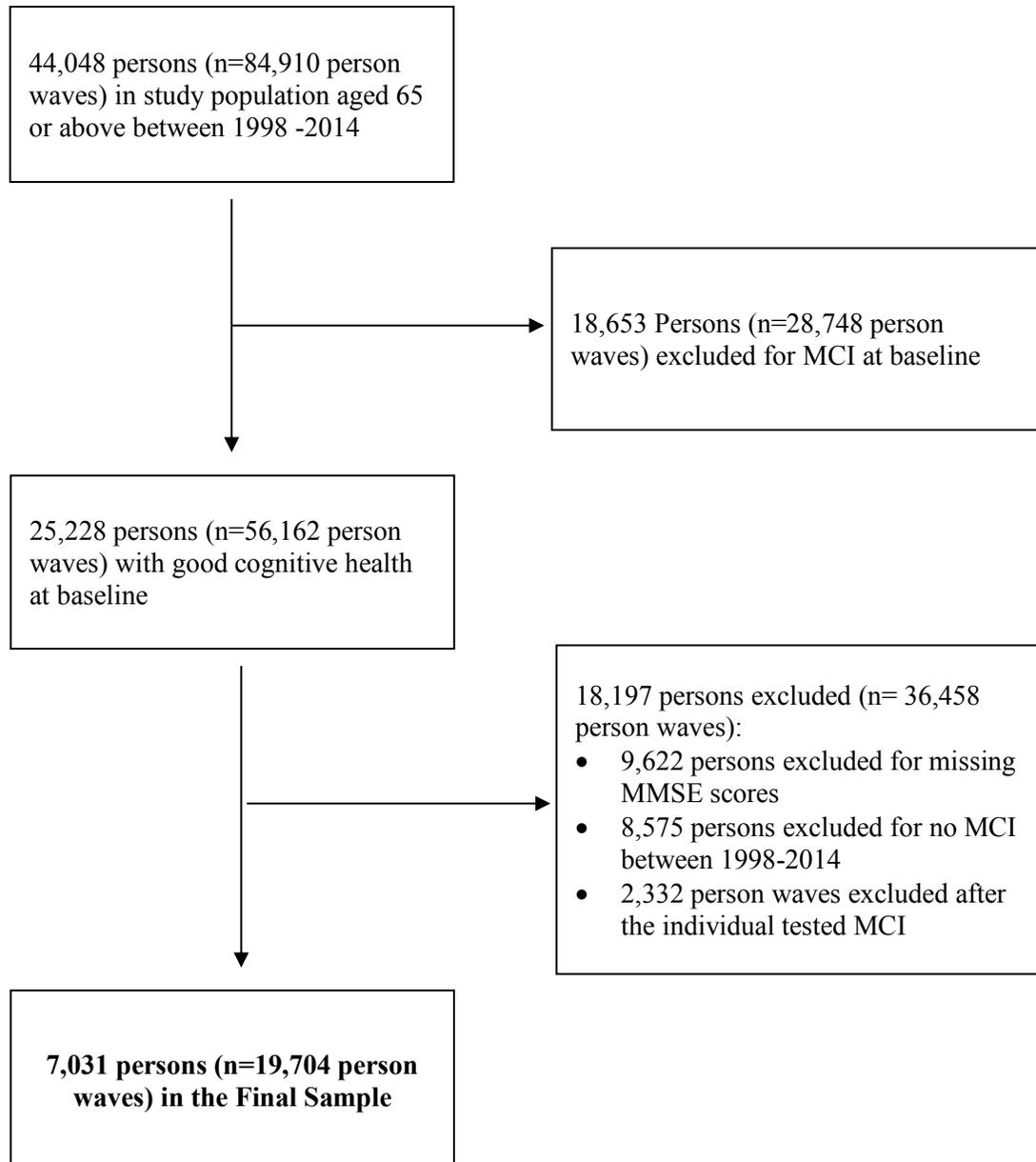


Figure 2. Study Population

Study Population

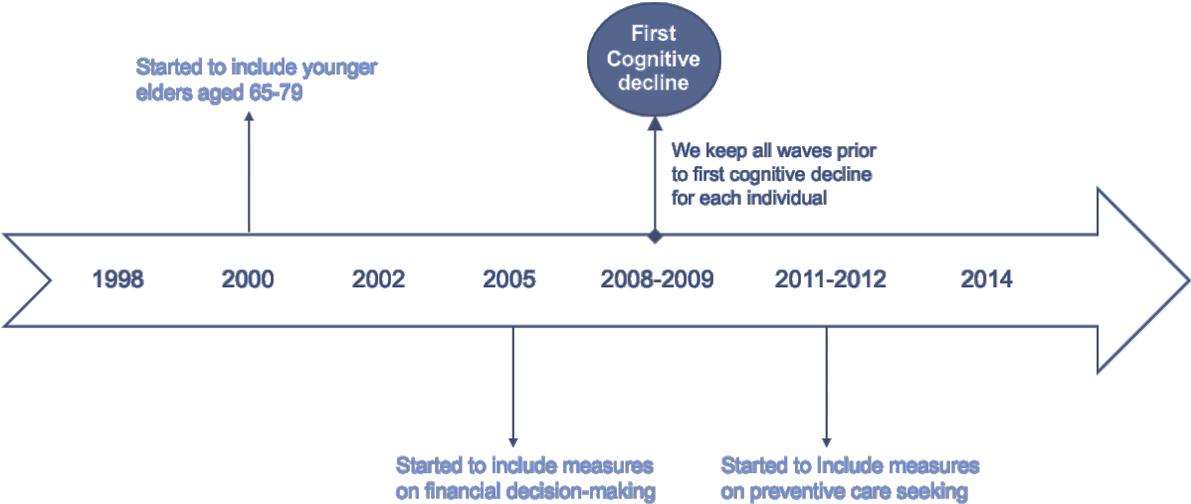


Table 1

Table 1 Time-invariant Sample Characteristics			
		NO	%
No. of persons		7,031	
No. of person waves		19,704	
<i>Time-invariant Characteristic</i>			
Sex	Male	2,891	41%
	Female	4,140	59%
Education	No education	4,533	64%
	Went to school	2,498	36%
Main occupation before age 60	Workers and others	4,231	60%
	Farmers and housework	2,767	39%
	Missing	33	0%
Number of children ever born	0-3 children	2,325	33%
	4-6 children	3,189	45%
	More than 6 children	1,517	22%
Number of siblings	0-2 siblings	2,764	39%
	3-4 siblings	2,386	34%
	More than 4 siblings	1,881	27%

Table 2A

Table 2A Sample Characteristics before and at MCI (Decision making on daily errands)

		N=19,704					
		Before MCI			At MCI		
		No. of observations	Outcome (perdeci_2==1) No.	(%)	No. of observations	Outcome (perdeci_2==1) No.	(%)
		12,673	7795	62%	7031	2632	37%
Demographics							
Validated age	Age 65-75	2,006	1,337	67%	480	239	50%
	Age 76-85	4,427	2,843	64%	1,572	708	45%
	Age 86-95	4,484	2,647	59%	2,987	1,075	36%
	Age 96+	1,756	968	55%	1,992	610	31%
Sex	Male	5,386	3,565	66%	2,869	1,099	38%
	Female	7,287	4,230	58%	4,162	1,533	37%
Category of co-residence	Alone	1,986	1,479	74%	1,026	585	57%
	Living with someone else	10,680	6,314	59%	5,875	2,045	35%
	Missing	2	1		1	1	
Education	No education	7,829	4,552	58%	4,546	1,684	37%
	Went to school	4,844	3,243	67%	2,485	948	38%
Category of residence	Urban	5,798	3,806	66%	3,486	1,422	41%
	Rural	6,875	3,989	58%	3,545	1,210	34%
Main occupation before age 60	Workers and others	8,565	5,222	61%	5,352	2,014	38%
	Farmers and housework	3,989	2,519	63%	1,496	579	39%
	Missing	20	10		9	2	
Marital status	Currently single	8,780	5,196	59%	5,630	2,011	36%
	Currently married	3,893	2,599	67%	1,401	621	44%
Number of children ever born	0-3 children	3,996	2,498	63%	2,283	836	37%
	4-6 children	5,883	3,621	62%	3,124	1,211	39%
	More than 6 children	2,794	1,676	60%	1,624	585	36%
Number of siblings	0-2 siblings	4,793	2,933	61%	2,541	926	36%
	3-4 siblings	4,214	2,584	61%	2,059	814	40%
	More than 4 siblings	3,666	2,278	62%	2,431	892	37%
Health status							
Poor self-reported quality of life	No	12,035	7,457	62%	5,260	2,408	46%
	Yes	637	337	53%	1,636	224	14%
	Missing	1	1		1	0	
Poor self-reported health status	No	11,243	6,991	62%	4,287	2,056	48%
	Yes	1,429	803	56%	2,608	576	22%
	Missing	1	1		1	0	
ADL	No ADL	10,805	6,692	62%	3,791	1,733	46%
	At least 1 ADL	1,868	1,103	59%	3,240	899	28%
Have smoke history	No	8,337	4,881	59%	4,698	1,662	35%
	Yes	4,336	2,914	67%	2,333	970	42%
Have drink history	No	8,462	5,064	60%	4,713	1,711	36%
	Yes	4,211	2,731	65%	2,318	921	40%
Have exercise history	No	6,833	3,892	57%	3,874	1,301	34%
	Yes	5,840	3,903	67%	3,157	1,331	42%
Financial status							
Main source of financial support	Retirement wage and others	4,091	3,004	73%	1,805	831	46%
	Family members	8,578	4,790	56%	5,097	1,797	35%
	Missing	2	1		0	2	
Sufficient financial support	No	2,054	1,110	54%	1,672	563	34%
	Yes	8,796	5,485	62%	5,224	2,065	40%
	Missing	5	3		5	2	

Table 2B

Table 2B Sample Characteristics before and at MCI (Decision making on household financials)

		N=19,704					
		Before MCI			At MCI		
		No. of observations	Outcome (own_findec==1) No.	(%)	No. of observations	Outcome (own_findec==1) No.	(%)
		12,673	4795	38%	7031	2415	34%
Demographics							
Validated age	Age 65-75	2,006	1,104	55%	480	339	71%
	Age 76-85	4,427	1,677	38%	1,572	731	47%
	Age 86-95	4,484	1,567	35%	2,987	935	31%
	Age 96+	1,756	447	25%	1,992	410	21%
Sex	Male	5,386	2,111	39%	2,869	1,039	36%
	Female	7,287	2,684	37%	4,162	1,376	33%
Category of co-residence	Alone	1,986	1,002	50%	1,026	558	54%
	Living with someone else	10,680	3,790	35%	5,875	1,855	32%
	Missing	2	2		1	0	
Education	No education	7,829	2,794	36%	4,546	1,500	33%
	Went to school	4,844	2,001	41%	2,485	915	37%
Category of residence	Urban	5,798	2,111	36%	3,486	1,163	33%
	Rural	6,875	2,684	39%	3,545	1,252	35%
Main occupation before age 60	Workers and others	8,565	4,023	47%	5,352	2,000	37%
	Farmers and housework	3,989	698	17%	1,496	339	23%
	Missing	20	5		9	2	
Marital status	Currently single	8,780	3,011	34%	5,630	1,736	31%
	Currently married	3,893	1,784	46%	1,401	679	48%
Number of children ever born	0-3 children	3,996	1,448	36%	2,283	710	31%
	4-6 children	5,883	2,417	41%	3,124	1,174	38%
	More than 6 children	2,794	930	33%	1,624	531	33%
Number of siblings	0-2 siblings	4,793	1,704	36%	2,541	823	32%
	3-4 siblings	4,214	1,516	36%	2,059	679	33%
	More than 4 siblings	3,666	1,575	43%	2,431	913	38%
Health status							
Poor self-reported quality of life	No	12,035	4,515	38%	5,260	2,024	38%
	Yes	637	280	44%	1,636	383	23%
	Missing	1	0		1	1	
Poor self-reported health status	No	11,243	4,137	37%	4,287	1,704	40%
	Yes	1,429	658	46%	2,608	702	27%
	Missing	1	0		1	1	
ADL	No ADL	10,805	4,354	40%	3,791	1,810	48%
	At least 1 ADL	1,868	441	24%	3,240	605	19%
Have smoke history	No	8,337	3,132	38%	4,698	1,585	34%
	Yes	4,336	1,663	38%	2,333	830	36%
Have drink history	No	8,462	3,201	38%	4,713	1,610	34%
	Yes	4,211	1,594	38%	2,318	805	35%
Have exercise history	No	6,833	2,507	37%	3,874	1,301	34%
	Yes	5,840	2,288	39%	3,157	1,114	35%
Financial status							
Main source of financial support	Retirement wage and others	4,091	1,891	46%	1,805	841	47%
	Family members	8,578	2,901	34%	5,097	1,567	31%
	Missing	2	1		0	2	
Sufficient financial support	No	2,054	949	46%	1,672	565	34%
	Yes	8,796	3,841	44%	5,224	1,848	35%
	Missing	5	0		5	1	

Table 3

Table 3 The Effect of Cognitive Decline on Personal Decision-making among Older Adults and Subgroups

Study Population	NO.	Coefficients	[95% CI]
Overall	17,002	-0.104***	(-0.124 - -0.0837)
Demographics			
<i>Sex</i>			
Male	7,115	-0.124***	(-0.156 - -0.0916)
Female	9,887	-0.0907***	(-0.117 - -0.0645)
<i>Category of co-residence</i>			
Alone	2,712	-0.0834***	(-0.137 - -0.0303)
Living with someone else	14,287	-0.105***	(-0.128 - -0.0815)
<i>Education</i>			
No education	10,670	-0.0951***	(-0.121 - -0.0694)
Went to school	6,332	-0.115***	(-0.148 - -0.0824)
<i>Marital status</i>			
Currently single	12,268	-0.105***	(-0.129 - -0.0807)
Currently married	4,734	-0.0903***	(-0.133 - -0.0477)
<i>Number of children ever born</i>			
0-3 children	9,057	-0.111***	(-0.139 - -0.0826)
More than 3 children	7,945	-0.0922***	(-0.122 - -0.0623)
<i>Number of siblings</i>			
0-2 siblings	10,658	-0.0859***	(-0.112 - -0.0593)
More than 2 siblings	6,344	-0.106***	(-0.145 - -0.0677)
Health status			
<i>Poor self-reported health status</i>			
No	13,117	-0.0792***	(-0.103 - -0.0551)
Yes	3,885	-0.150***	(-0.224 - -0.0749)
<i>ADL</i>			
No ADL	12,590	-0.0885***	(-0.113 - -0.0643)
At least 1 ADL	4,412	-0.0996***	(-0.159 - -0.0406)

*** p<0.01, ** p<0.05, * p<0.1

Table 4

Table 4 The Effect of Cognitive Decline on Financial Decision-making among Older Adults and Subgroups			
Study Population	NO.	Coefficients	[95% CI]
Overall	10,716	-0.102***	(-0.124 - -0.0804)
Demographics			
<i>Sex</i>			
Male	4,389	-0.111***	(-0.145 - -0.0781)
Female	6,327	-0.0955***	(-0.124 - -0.0668)
<i>Category of co-residence</i>			
Alone	1,814	-0.0689***	(-0.112 - -0.0257)
Living with someone else	8,899	-0.107***	(-0.134 - -0.0806)
<i>Education</i>			
No education	6,768	-0.0966***	(-0.125 - -0.0686)
Went to school	3,948	-0.117***	(-0.152 - -0.0822)
<i>Marital status</i>			
Currently single	7,624	-0.0959***	(-0.124 - -0.0681)
Currently married	3,092	-0.0909***	(-0.130 - -0.0518)
<i>Number of children ever born</i>			
0-3 children	5,473	-0.110***	(-0.141 - -0.0793)
More than 3 children	5,243	-0.0944***	(-0.126 - -0.0630)
<i>Number of siblings</i>			
0-2 siblings	6,950	-0.111***	(-0.139 - -0.0823)
More than 2 siblings	3,766	-0.0766***	(-0.119 - -0.0340)
Health status			
<i>Poor self-reported health status</i>			
No	8,074	-0.0979***	(-0.124 - -0.0721)
Yes	2,640	-0.101**	(-0.179 - -0.0238)
<i>ADL</i>			
No ADL	8,066	-0.0738***	(-0.0979 - -0.0498)
At least 1 ADL	2,650	-0.206***	(-0.288 - -0.124)

*** p<0.01, ** p<0.05, * p<0.1

Table 5

Table 5 The Effect of Cognitive Decline on Care Seeking Pattern among Older Adults and Subgroups			
Study Population	NO.	Coefficients	[95% CI]
Overall	3,616	-0.0231	(-0.0694 - 0.0232)
Demographics			
<i>Sex</i>			
Male	1,461	-0.00557	(-0.0757 - 0.0646)
Female	2,155	-0.0275	(-0.0878 - 0.0329)
<i>Category of co-residence</i>			
Alone	647	0.140**	(0.0193 - 0.261)
Living with someone else	2,969	-0.0414	(-0.0963 - 0.0135)
<i>Education</i>			
No education	2,291	-0.0105	(-0.0697 - 0.0488)
Went to school	1,325	-0.0355	(-0.114 - 0.0435)
<i>Marital status</i>			
Currently single	2,583	-0.0224	(-0.0818 - 0.0370)
Currently married	1,033	0.00190	(-0.0794 - 0.0832)
<i>Number of children ever born</i>			
0-3 children	1,786	-0.0220	(-0.0958 - 0.0517)
More than 3 children	1,830	-0.00706	(-0.0695 - 0.0554)
<i>Number of siblings</i>			
0-2 siblings	2,796	-0.0192	(-0.0739 - 0.0355)
More than 2 siblings	820		
Health status			
<i>Poor self-reported health status</i>			
No	2,548	-0.00336	(-0.0613 - 0.0546)
Yes	1,066	-0.0290	(-0.188 - 0.130)
<i>ADL</i>			
No ADL	2,405	-0.00609	(-0.0618 - 0.0497)
At least 1 ADL	1,211	0.0990*	(-0.0111 - 0.209)

*** p<0.01, ** p<0.05, * p<0.1

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