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Economic Stress, Quality of Life, and Mortality for the Oldest-Old in China

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Abstract China's oldest old population is estimated to quadruple by 2050. Yet, poverty rate for the oldest old has been the highest among all age groups in China. This paper investigates the relationship between economic stress, quality of life, and mortality among the oldest-old in China. Both objective economic hardships and perceived economic strain are examined. We base our investigation on data drawn from the Chinese Longitudinal Healthy Longevity Survey conducted between 2000 and 2005. Our sample includes 10,972 men and women between the ages of 80 and 105 in 2000. The data show that about 16% of these oldest-old lived under economic stress in 2000. The risk factors that make one vulnerable to economic stress include age, being male, being widowed or never married, being a minority member, having no education, having no living children, and not having children as main source of income, and having no pension. Economic stress is negatively associated with indicators of quality of life, such as the quality of medical care and mental well-being. The poor quality of life contributes to the higher mortality rate for the oldest old who are under economic stress. Results also show that perceived economic strain increases the risk of mortality by 42% in rural areas, even after controlling for basic demographic characteristics, life style factors, and major health events. For the rural oldest-old, having children as a main source of income and having access to pension alleviates the negative impact of economic hardship on mortality hazard by 23 and 66% respectively. However, in urban areas, economic stress has no direct impact on the hazard of mortality.

Keywords Economic stress · Quality of life · Elderly · Oldest-old · China · Mortality

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1 Introduction

China's oldest old population is estimated to quadruple by 2050. Yet, poverty rate for the oldest old has been the highest among all age groups in China. The impact of economic stress on health remains largely unexplored with the exception of several longitudinal studies conducted in European countries or in America (Stuckler et al. 2009). China, having undergone dramatic demographic and economic transformations since the 1950s, provides a unique context for understanding the link between economic stress and health under a different cultural and policy regime.

Research has shown that economic stress can affect various indicators of physical and mental health. Evidence of the effect of economic stress on mortality is mixed. At an aggregate level, the Russian Federation suffered a major increase in male mortality in the early 1990s, and mortality increased in Thailand during the 1990s' Asian Economic Crisis, while on the other hand, short-term mortality effects of the South Korean economic crisis were relatively small (Khang et al. 2005; Khang and Lynch 2010). Catalano (2003) and Catalano et al. (2005) show that poor macroeconomic conditions seem to induce a biological response in men and women. Ruhm (2000) and Van Den Berg et al. (2009) show a relationship between economic recession and individual health. A longitudinal study on women with breast cancer found that patients who reported concerns about job security, medical costs, or financial stress at the baseline had significantly poorer functional, mental and affective well-being over the subsequent 12 months (Ell et al. 2008). A body of research has shown that stress and depression tend to trigger inflammatory response, enhancing proinflammatory cytokine production (Goebel et al. 2000; Steptoe et al. 2007; Maes et al. 2000; Kendall-Tackett 2009; Miller et al. 2005). Depressive symptoms were linked to increased IL-6, TNF-α, and CRP in community samples of older adults (Lutgendorf et al. 2008; Kiecolt-Glaser et al. 2003; Glaser et al. 2003).

Friedman and Thomas (2008) used data from the Indonesia Family Life Survey to examine the impact of the 1997 Asian financial crisis on individuals' psychological well-being. They found that the crisis had detrimental consequences on psychological well-being (depression, anxiety, and lowered aspirations) across the entire age group distribution over the crisis period. The impact was strongest on the low education group, the rural landless, and residents in the hardest hit areas. Furthermore, the negative impact persisted after the financial crisis, suggesting that financial crisis has long-term deleterious effects on one's psychological well-being.

Two Swedish and Finnish studies showed that parental economic stress was significantly associated with children's low self-rated health even when accounting for employment status and foreign origin. They found that trauma such as a major economic shock triggered the inflammatory response in people. In view of the potential health consequences of economic stress, researchers such as Dooley and Catlano (1984) have underscored the significant epidemiology of economic stress, and others have argued that: "It, therefore, deserves to be seriously considered as a potential public health risk factor among families" (e.g., Olivius et al. 2004).

This paper examines the relationship between economic stress, quality of life, and health for the oldest-old population in China. We start by describing the social-demographic contexts in China today that are crucial for understanding the relationships under investigation. We then move to describe a conceptual framework which integrates microeconomic and sociopsychological perspectives (Conger and Elder 1994). We consider factors that may mediate the relationship between economic stress and mortality,

including the adequacy of medical care and the mental health of the oldest old. We also take into account several moderators that may affect this relationship, including the human capital and social support of the elderly and the psychological attributes of the oldest old. We end with a discussion about the implications of our results for China's challenge in caring for the elderly.

2 Recent Social Contexts for the Elderly in China

China has experienced a dramatic decline in fertility due to the one-child policy and an unprecedented speed of socioeconomic development since the economic reform in the late 1970s. As a result, the Chinese population is aging at a rate faster than those in many developed countries. China's 2010 Population Census reported the proportion of those 65 and above increased from 6.96% in 2000 to 8.87% in 2010 (National Bureau of Statistics of China 2010). It is forecast to be 17% in 2030, and 27% in 2050 (Chinese Ministry of Civil Affairs Report 2010). The proportion of the oldest-old (80 years and older) among the elderly (65 years and older) is expected to climb rapidly, from 14% in 2000 to 34.4% in 2050, amounting to 114 million (Zeng and George 2000). This demographic landscape presents a tremendous challenge for the Chinese society to support and care for the elderly because both private and public assistance for the elderly have weakened in China in the past few decades.

The availability of family support for the Chinese elderly has dwindled as the number of children and kin to provide care has declined and the old age dependency ratio has increased drastically since the 1979 one-child policy. Many single children will shoulder the responsibility of caring for their parents and grandparents, resulting in the infamous "4-2-1" problem. This problem is particularly salient in light of the combination of the nature of caregiving tasks and the increasingly skewed sex ratio in China since the initiation of the one-child policy. As the caregiving responsibility often falls on the shoulders of daughters and daughters-in-law, the "missing girls" problem makes the challenge of caring for the elderly even more formidable.

To address the challenge of elderly care, the Chinese government has explicitly written into the laws that require children to care for elderly parents in China. Marriage Law of P.R. China stipulates that children shall be under the obligation to support their parents; where any child fails to perform his or her obligations, the parents who are unable to work or who are living a difficult life shall be entitled to ask their child(ren) to provide aliments. In addition, according to the Law of P.R. China on the Protection of Rights and Interests of the Aged launched in 1996, a child of the aged person should perform the duty of paying for the aged person's living expenses, looking after him, providing emotional support and giving consideration to his special requirements. Despite these laws, economic stress among the elderly remains pervasive, particularly among those who live in the rural areas, where many young adults migrate to the cities for work.

In the public domain, the social safety nets for the elderly in China have weakened since the economic reform started. Health care provision has increasingly been privatized and out-of-pocket medical costs borne by individuals have skyrocketed. The China National Health Service Survey reported that the percentage of out-of-pocket cost of health care increased by about 60% from 1992 to 1997, from 28 to 44% (England 2005). A substantial proportion of elderly do not have medical insurance or access to adequate medical care. Secondly, the pension system is not well established and not available to many people. Again, rural elderly face particularly hard times due to very weak public safety nets in most rural areas.

To appreciate the intricacy of China's public safety nets system, one needs to understand the *hukou* system initiated in the late 1950s, which serves as the most predominant social stratification mechanism in China since then. The system assigns people, according to an individual's parents' birth place, to either agricultural or non-agricultural *hukou* status. Since the late-1950s, this system was used to officially differentiate between residential groups and for controlling their movement. The *hukou* system is also used by the Chinese government to allocate socioeconomic benefits, such as income, housing, social security, medical care, education and retirement benefits, according to one's residence (Cheng and Selden 1994). As a result, two different worlds have been created; while the "urban aristocrats" are entitled to these benefits, those in rural areas are left to fend for themselves with little social security or public health services. Research has shown that the *hukou* system is a main contributing factor to urban–rural economic and social inequality (Selden 1999; Wu and Treiman 2007).

3 Poverty Rate Among Chinese Elderly

Research by Wang and Zhang (2005) examined elderly poverty in China based on subjective assessment by the elderly of their own financial circumstances. The elderly were asked if they felt their financial resources were "more than sufficient", "have some surplus", "just sufficient to make ends meet", "somewhat insufficient", or "very insufficient". Those who felt that their financial situation was very difficult were defined as "poor". This study found that there were 9.2–11.7 million elderly living in poverty in 2000, accounting for about 7.1–9.0% of the elderly population. Moreover, poverty has been shown to be more prevalent in rural than in urban areas, with 4.2–5.5% of urban elderly, as opposed to 8.6–10.8% rural elderly, living in poverty. Qiao et al. (2005), based on objective indicators that use the urban minimum subsistence level to represent urban absolute poverty with 30% of the urban minimum subsistence level as the rural absolute poverty level, reported that the poverty rate for Chinese elderly was 17.5% in 2000.

The poverty rates in China have also been found to be higher for the elderly than for other age groups. The Sampling Survey of the Aged Population in China conducted in 2000 shows that the proportion of the poor among those aged 60–64 was 11.3%, and this proportion increased dramatically to 22.6% for those aged 75–79, 27.7% for those aged 80–84, and to 30.3% for those aged 85–89 (Qiao et al. 2006). Elderly females, those who resided in rural areas, were less educated, and who had no pension were more likely to be at higher risk of poverty than other groups. Since the rural elderly were not entitled to a pension, they had little choice but to turn to their children for assistance (Zeng 1995).

4 Methods

Given these socioeconomic contexts in China, we examine how quality of life indicators of economic stress affects the mortality hazard of the elderly. We propose a conceptual framework to guide our analysis (shown in Fig. 1).

This framework integrates two strains of thoughts: (1) microeconomic theories that see family members pooling resources and smoothing life course consumptions over time, and (2) the family stress theory that takes sociopsychological factors into account (Conger and Elder 1994). Objective economic stress, measured by indicators such as financial or

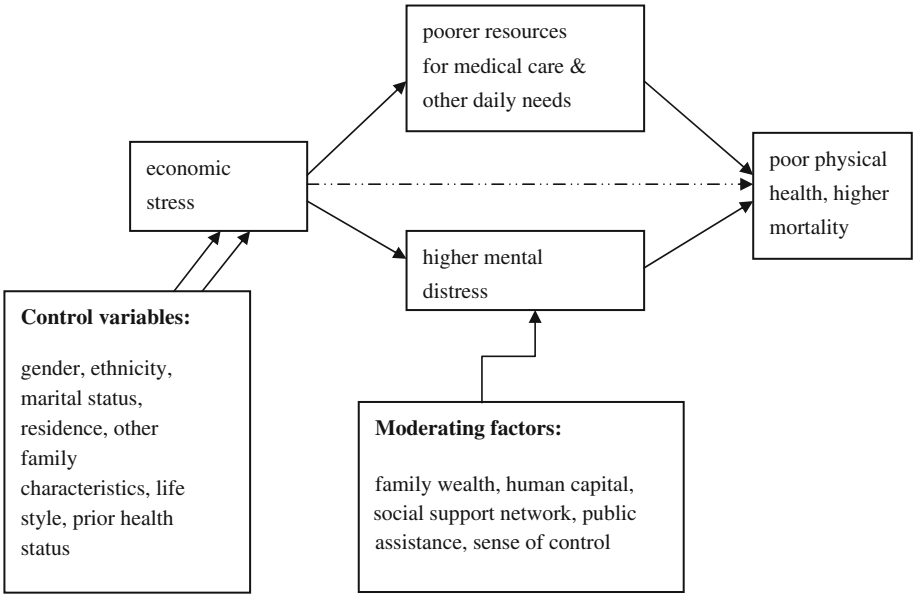

Fig. 1 Conceptual framework for the relationship between economic stress and health

material deprivation, often triggers a certain level of subjective economic strain/pressure among family members.

We hypothesize that economic stress of the oldest-old has both direct and indirect effects on mortality. Poorer financial resources are likely to lead to poorer medical care and higher mental distress, which will then have negative effects on one's health and vulnerability to the hazard of mortality. However, there are several factors that may potentially moderate the impact of economic stress on health. These factors include the stock of family wealth and human capital of the oldest-old, the social support network available to them, and the public assistance they receive. Another potential moderator is the psychological resources available to the elderly. Strong psychological resources may help insulate the oldest-old from the harm of stressors and allow him or her to cope better in times of economic stress. One such psychosocial resource that has been given much attention to in the literature is an individual's sense of control. Previous research has shown that one's sense of control not only reduces stress but influences one's ability to manage life challenges (Turner and Noh 1988; Kessler et al. 1988; Pearlin et al. 1981).

5 The Data

We drew our data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) conducted between 2000 and 2005. The CLHLS was launched in 1998 in China. In 2000, 2002, 2005 and 2008, follow-up surveys were conducted. The sample was randomly collected from half of the counties and cities in 22 of China's 31 provinces, which constitutes about 85% of the total population in China (Zeng 2008). The CLHLS interviewed 8,959 and 11,161 individuals aged 80–112 in 1998 and 2000 respectively, and 16,057 and 15,638 individuals aged 65–112 in 2002 and 2005 respectively. In the four waves of the

study from 1998 to 2005, the survivors in the baseline were re-interviewed, and deceased interviewees were replaced with new participants.

In the 2000 survey, an item that was critical for our analysis was added to the survey. This question assessed whether income from all sources for the oldest-old was sufficient to support his or her daily needs. We used this information as one of our key indicators of "economic stress". Therefore, we drew our data from the 2000, 2002 and 2005 panel surveys. Our sample included 10,972 men and women between the ages of 80 and 105 in 2000.

Of the 10,972 oldest-old interviewed in 2000, 18.5% had died before the 2002 interview and 12% were lost via the follow-up interview. This left about 70% of the original oldest-old ($n = 7{,}600$) in the sample in 2002. Between 2002 and 2005, about 23.5% of them had passed away, and 6.4% were lost due to attrition. At the time of the 2005 interview, only 39.4% of the original respondents ($n = 4{,}322$) were still alive. In all our analyses, sampling weights were used to adjust for differential sampling probability and attrition rates.

6 Measures

6.1 Independent Variable

The main independent construct in our study was economic stress. We measured this construct with both objective indicators of economic hardships and a subjective indicator of the perceived economic strain for the elderly.

For the objective economic hardship measures, data for household income or earnings were unfortunately not available in the 2000 survey. We used several alternative indicators of economic hardships in this paper. These measures included (1) whether the oldest-old were receiving welfare from the government or community assistance, (2) the frequency of fruit consumption among the oldest-old, and (3) whether the oldest-old had access to tapped water.

The Chinese government provides a meager amount of welfare to the very poor to support them in their daily lives. According to official reports and statistics, the amount of financial aid in urban areas varies across areas, with a monthly average of about RMB 150 (approximately $25USD) per person (Chinese Civil Affairs Statistical Yearbook 2008). The frequency of fruit consumption was used as an indicator of the quality of life. As fruits are more expensive and not often considered as a basic necessity in daily life in China, we took it as another indication of daily financial difficulty if an elderly rarely or never ate fruits. This variable was measured in the survey on a 4-point scale, with 1 indicating "almost every day" and 4 indicating "rarely or never". The third indicator of economic stress was the absence of tapped water for daily drinking for the oldest-old. The original survey question enquired regarding the source of drinking water; whether it was from a well, lake or river, spring, pond or pool, or tap water. We constructed a variable indicating whether the oldest-old had access to tap water for daily drinking. We also included a childhood economic stress indicator in our preliminary analysis. This measure enquired whether the oldest-old often went to bed hungry during his or her childhood. Results showed that this childhood economic stress was very pervasive (two-thirds of the elderly had such an experience) indicating that this variable reflected the general economic difficulty in China at the turn of the twentieth century. This variable did not have a significant impact on the mortality of the oldest-old, so we do not report these results in this paper. Economic stress theories postulate that objective economic stress induces perceived

(subjective) economic strain which then exerts a more direct impact on the well-being of the elderly. We measured subjective economic stress (economic strain) with an indicator that assessed whether the oldest-old perceived income from all sources as sufficient to support all his or her daily expenditures at the time of the 2000 interview. These income sources included pension, spouse, child, grandchild, other relatives, local government or community, income from own work, and any other sources.

6.2 Dependent Variable

The dependent variable was the hazard rate of mortality. We examined the hazard of mortality from 2000 to 2005 for the 8,928 men and women interviewed in 2000. This dependent variable was a time-variant variable, indicating whether the respondents in 2000 had or had not passed away by 2005 at different time points. The unit of time for the dependent variable was the number of days under risk. The dependent variable recorded two dimensions of the mortality hazard. The first dimension was whether the respondents who entered observation in the 2000 interview had or had not died by the time of the follow-up surveys. The other dimension was the time stage which referred to the number of days between entry and exit in the analysis.

6.3 Moderators

As depicted in the conceptual framework, several factors including one's human capital, social support network, public assistance, and sense of control can potentially moderate the impact of economic stress on health. We measured human capital with educational attainment and occupation of the oldest-old. As the Chinese oldest-old generally have low educational attainment, we divided the years of school into three categories: (1) none (2) 1–5 years, and (3) six or more years. Occupational level was measured with the occupational status of one's job before the age of 60. Occupational status was defined as high for professional and technical personnel, and governmental, institutional or managerial personnel, and as low for all other occupations, including agricultural, forestry, animal husbandry, industrial, service fishery workers, military personnel, housework, and others.

The social support network of the oldest-old was measured with (1) whether he or she had at least one living child, and (2) whether the main financial support came from children in 2000, and (3) whether the oldest-old was receiving a pension.

Another potential mediator in this framework was the psychological attributes of the oldest-old, specifically the extent to which the elderly felt he or she was in control. We assessed their sense of control by measuring the degree to which the elderly felt he or she had a say in matters concerning himself or herself in daily living. This scale ranged from 1 indicating "never" to 5 "always".

6.4 Mediators: Quality of Medical Care and Mental Distress

We hypothesized that the impact of economic stress on health was mediated by the quality of medical care and the psychological well-being of the oldest-old. The quality of medical care was measured in terms of whether the oldest-old was able to obtain immediate medical service when ill. We created a dichotomized variable for "poor medical care" from these data.

To consider mental well-being, we included indicators of psychological resources associated with the positive and negative aspects of the oldest-old's emotions. Mental distress was measured with four items in 2000 and 2002: Optimism ("I look at the bright side of things"), Conscientiousness ("I like to keep my belongings neat and clean"), Neuroticism ("I often feel fearful or anxious"), and Loneliness ("I often feel lonely and isolated"). These items measured psychological resources for the well being of the oldest old (Smith et al. 2008; Wu and Schimmele 2006). Responses were recorded in a 5-point scale (0-always, 1-often, 2-sometimes, 3-seldom, and 4-never). The last two items (Neuroticism and Loneliness) for the negative aspects of emotions were reverse coded. The overall index was derived from the average score on the four items with a range of '0' to '4' (Cronbach's $\alpha = 0.629$), with a higher score indicating a higher level of mental distress. Both mediators were measured in two points of time—2000 and 2002.

6.5 Other Control Variables

We controlled for basic demographic characteristics, the life style and diet consumption of the oldest-old. Basic demographic variables included age, gender, ethnicity, residence, and marital status. Ethnicity was measured by whether he or she was Han. Residence was measured by whether the oldest-old resided in an urban (city and town) or rural area at the time of the 2000 interview. We also controlled for three aspects of the life style—whether or not the oldest-old smoked, drank, or exercised in the past. They are dichotomous variables. For diet, we created an index of protein consumption composed of the frequency of meat, fish and egg consumption measured on a 3-point scale with 1 indicating "rarely or never" and 3 indicating "almost every day".

We also controlled for baseline health status, activities of daily living (ADL) and the cognitive functioning of the oldest-old. Self-reported health was measured on a 5-point scale, which we later collapsed into 3 categories, with 1 indicating "very good and good", 2 indicating "so–so", and 3 indicating "poor and very poor". We created the cumulated activities of daily living index (ADL index) with six items—bathing, dressing, visiting the toilet, transferring, continence and feeding (Katz et al. 1963). Each item ranged from 1 to 3, with 3 indicating the highest level of disability. Additionally, we measured the cognitive functioning of China's oldest-old using the Chinese version of Mini-Mental State Examination (MMSE), which records four aspects of cognitive functioning—orientation, calculation, recall and language (Folstein et al. 1975). MMSE has been widely used in measuring cognitive impairment (Nguyen et al. 2003; Schultz-Larsen et al. 2008). It covers 30 questions, and the respondents received one point for answering each question correctly. Respondents who scored less than 18 was considered cognitively impaired, based on the previous studies (Zhang 2006).

In addition, about 36% of the interviews were conducted with a proxy respondent at the time of the 2000 interview. This was often done when the respondents were too impaired to participate in the survey. We created a variable indicating whether a proxy respondent was used as a control for both the quality of the report and as an indicator of the disability status of the oldest-old.

7 Analytical Strategy

Sampling weights were applied to all analyses in this paper to adjust for initial selection probability and attrition over time. First, we investigated potential risk factors for living

under economic stress, including the basic demographic characteristics, baseline health status, personal support network, and public assistance. Then we examined whether economic stress had an effect on mortality through (1) the quality of medical care, and (2) emotional distress of the oldest-old.

Subsequently, we estimated the Kaplan–Meier survival curves (Kaplan and Meier 1958), comparing those who lived under economic stress in 2000 to those who did not. As shown in the formula below, n_j represents the number of respondents who had not died and were not censored at t_0-the beginning of time period t, d_j represents the number of respondents who died during this period, and $S(t)$ denotes the outcome of survival probabilities in t and the preceding periods.

$$S(t) = \prod_{j=t_0}^{t} \{(n_j - d_j)/n_j\}$$

Finally, Cox's proportional hazard model was used to estimate the impact of economic stress on the hazard rates of mortality from 2000 to 2005. This model stipulated that the hazard rate for the nth subject was

$$h(t|x_n) = h_0(t)\exp(x_n\beta_x)$$

where the regression coefficients β_x were to be estimated from the data (Cox 1972). The exponentiated individual coefficient exp (β_x) represented the ratio of the hazards for a one-unit change in the corresponding covariate.

Due to the distinct socioeconomic contexts and social support network available to the elderly in urban and rural areas, we estimated separate models for urban and rural residence. Results provided convincing evidence in support of the difference in the impact of economic stress on the hazard of mortality by residence.

8 Results

Table 1 shows the weighted descriptive statistics for the entire sample by residence. Overall, one third of the sample lived in urban areas. Those in urban areas had a higher living standard and socioeconomic status and were more likely to receive benefits. First, we examined the four indicators of the economic stress experienced by the oldest-old in 2000. Overall, about 16% of the oldest-old received welfare or felt they lived under economic strain, and about half did not have access to tap water. In the urban area, about 20% of the oldest-old had no access to tap water, as opposed to nearly 67% in rural areas. The oldest-old in urban areas ate fruits more often compared to those in rural areas.

The mean age of the sample was 84. The ethnic minority groups accounted for 6% of the sample which was about the national average. In terms of the marital status, the majority of the oldest-old (about 70%) were widowed, 28% were still married, 1% was divorced, and another 1% was never married.

The majority of the oldest-old did not have any formal education (56% in urban areas and 70% in rural areas), about a quarter of them had 1–5 years of education, 11% had six or more years of education (18% in urban areas vs. 7% in rural areas). Only a small proportion of them had a high status occupation before, most of them in urban areas (13% in urban areas vs. 2% in rural areas). In terms of life style, about one-third of oldest-old drank, and smoked in the past in both urban and rural areas, but more urban oldest-old exercised than their rural counterparts (45% in urban areas vs. 26% in rural areas).

Table 1 Descriptive statistics for the characteristics of the sample

	All		Urban	Rural
	N	Mean (SD)	Mean (SD)	Mean (SD)
Economic stress indicators				
Receiving welfare*	10,768	.16 (.36)	.15 (.36)	.16 (.37)
No tap water	10,972	.51 (.50)	.20 (.40)	.67 (.47)
Never or rarely eat fruits	10,970	2.92 (.91)	2.69 (1.06)	3.04 (.80)
Economic strain	10,736	.16 (.37)	.15 (.35)	.17 (.37)
Covariates				
Demographic and socioeconomic characteristics				
Age	10,972	83.7 (3.6)	83.9 (3.7)	83.6 (3.5)
Female*	10,972	.62 (.48)	.62 (.48)	.63 (.48)
Minority	10,952	.06 (.24)	.05 (.22)	.06 (.25)
Currently married	10,971	.28 (.45)	.31 (.46)	.28 (.45)
Divorced	10,971	.01 (.07)	.01 (.09)	.00 (.07)
Widowed	10,971	.70 (.46)	.67 (.47)	.71 (.45)
Never married*	10,971	.01 (.11)	.01 (.12)	.01 (.10)
No education	10,893	.65 (.48)	.56 (.50)	.70 (.46)
Education (1–5 years)	10,893	.24 (.43)	.26 (.44)	.23 (.42)
Education (>5 years)	10,893	.11 (.31)	.18 (.38)	.07 (.26)
High occupation	10,965	.06 (.23)	.13 (.33)	.02 (.14)
Life style				
Drank*	10,951	.30 (.46)	.30 (.46)	.29 (.46)
Smoked*	10,954	.34 (.47)	.35 (.48)	.34 (.47)
Exercised	10,944	.32 (.47)	.45 (.50)	.26 (.44)
Meat, fish, egg consumption	10,958	1.96 (.47)	2.03 (.50)	1.93 (.44)
Family structure				
Alone	10,972	.15 (.35)	.13 (.34)	.15 (.36)
With spouse only	10,972	.14 (.34)	.16 (.37)	.13 (.33)
With children	10,972	.62 (.48)	.57 (.49)	.65 (.48)
With others	10,972	.01 (.11)	.02 (.13)	.01 (.10)
Institution	10,972	.08 (.27)	.12 (.32)	.06 (.24)
Moderators—Family support Community support				
Have living child	10,685	.88 (.32)	.87 (.34)	.89 (.31)
Main financial source from children	10,972	.67 (.47)	.49 (.50)	.75 (.43)
Pension	10,800	.17 (.38)	.36 (.48)	.08 (.27)
Psychological attribute				
Sense of control	9,613	3.72 (1.12)	3.90 (1.12)	3.62 (1.11)
Prior Health Status				
Self-reported health*	10,077	1.56 (.71)	1.56 (.70)	1.56 (.72)
ADL index	10,972	.11 (.30)	.13 (.33)	.10 (.29)
Cognitive impaired*	10,972	.01 (.12)	.01 (.12)	.01 (.12)
Proxy	10,972	.36 (.48)	.29 (.45)	.40 (.49)

* Means not statistically different at .05 level

Regarding the living arrangements of the oldest-old, the majority of the oldest-old lived with children, more so in rural than in urban areas (57% in urban areas vs. 65% in rural areas). 16% and 13% lived only with spouse in urban and rural areas respectively. About 15% of them lived alone, a smaller proportion lived in an institution (12% in urban areas and 6% in rural area), and only 1% lived with others.

These oldest-old had their childbearing period before the initiation of the one-child policy. On average, they had 4.5 children. Five percent of the rural respondents, as opposed to 6.8% of those in urban areas, never had any children. On average, these oldest-old had 3.5 living children at the time of the 2000 interview while 11.7% had no living children.

As to the main source of income, a high proportion of the oldest-old relied on their children, though this proportion was much higher in the rural areas. About three-quarters of oldest-old in rural areas relied on children as his or her main source of income, compared to half of those in urban areas. Public assistance such as pension was not available to the majority of them, particularly to those in rural areas. 36% of the oldest-old in urban areas had pension while only 8% of those in rural areas did. In urban areas, a third of the oldest-old relied on pension as their main source of income (a more careful analysis reveals that these individuals tended to be those who had higher occupational status and education attainment). In contrast, in rural areas, only 6% of the oldest-old had pension as their main source of income.

The data also clearly showed that the oldest-old in rural areas received significantly poorer quality of medical care and experienced a higher level of mental distress than their counterparts in urban areas.

Figure 2 shows that those who felt they were under economic stress, on average, had poorer physical and mental health, with significantly more reporting "bad or very bad" health, having two or more chronic illnesses and limitation in activities of daily living. These relationships were also corroborated by multivariate analyses (results not shown due to space constraint). The data also showed that those who were under economic strain had poorer mental health and cognitive functioning, as well as a lower sense of control (data not shown). However, we will not focus on these health measures in this paper due to potential endogeneity problems in these analyses (since these health indicators were measured contemporaneously as economic stress in 2000). Instead, we focus on the mortality rate of the oldest old over the subsequent 5 years.

9 Risk Factors of Economic Stress

What were the factors that increased the risk of economic stress in old age? Table 2 shows that, for the oldest-old in the rural area, these risk factors included being aged, being male, having low or no education, being widowed or never married, having no living children, no pension, and not having children as main source of financial support. The finding that males were more likely to be under economic stress contradicts previous research. After further examination, however, we found that compared to females, more male oldest-old were never married (2.6% vs. 0.40%) and did not have children as their main source of income (44% vs. 27%). These factors partly explain why the male oldest-old was more likely to be under economic stress than his female counterpart. Previous studies did not control for many of these factors. Risk factors for economic stress also include physical health status. Specifically, diminished ability to engage in ADL is related to economic strain, perhaps because of the high medical costs related to elderly illnesses.

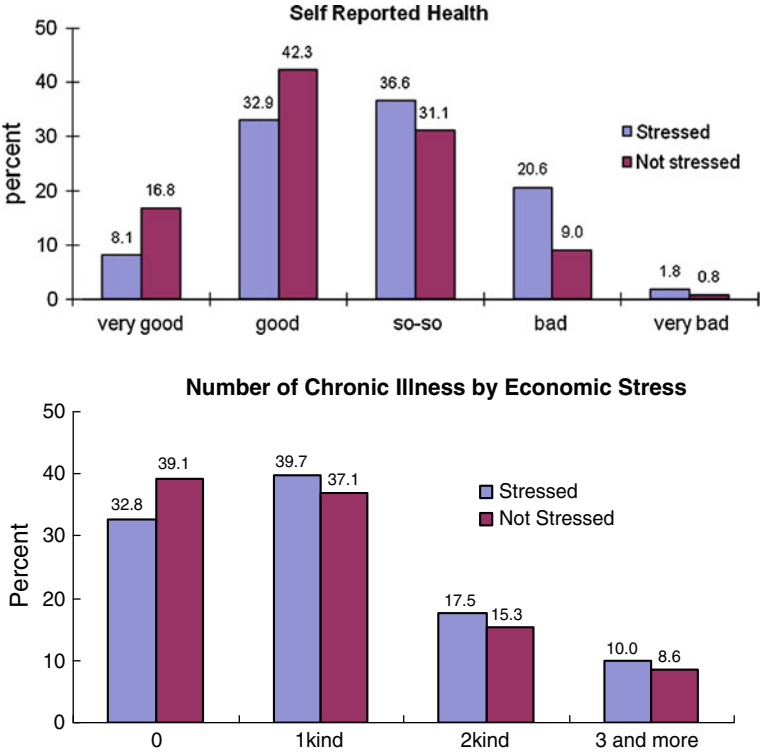

Fig. 2 Economic stress and the health status of the oldest-old in China

Consistent with the descriptive data, a lower sense of control level, poor self-reported health status, and impaired cognitive conditions are all significantly related to subjective economic strain.

10 Mediating Mechanisms

We hypothesized that economic stress affected the health of the oldest-old through its negative effect on (1) the quality of medical care and (2) mental health.

Table 3 shows that the oldest-old who felt they were under economic strain were about seven times more likely to receive poor quality medical care and were in greater emotional distress. Another indicator of economic stress, lack of fruit consumption (never or rarely) was also associated with a higher likelihood of receiving poor quality medical care in rural areas and a higher level of emotional distress. Having no access to tap water was significantly related to higher mental stress. Receiving welfare in fact reduced the likelihood of receiving poor quality medical care but increased mental stress in rural areas though not in urban areas. This may be indicative of the general negative relationship between economic stress and one's mental health despite the benefit of some medical assistance from the government. However, when the oldest-old had his or her children as the main financial source, the negative impact of economic strain on emotional distress decreased by 0.13% in urban and 0.17% in rural areas.

Table 2 Logistic regression estimates for the risk factors for economic stress

Variables	Urban		Rural	
	(1) Receiving welfare (odds ratio)	(2) Economic strain (odds ratio)	(3) Receiving welfare (odds ratio)	(4) Economic strain (odds ratio)
Age	0.997	0.991	1.034**	1.037***
	(0.016)	(0.015)	(0.011)	(0.011)
Female	0.778	0.819	0.758**	0.683***
	(0.120)	(0.110)	(0.069)	(0.061)
Minority	0.479*	1.593*	0.468***	2.837***
	(0.169)	(0.334)	(0.088)	(0.344)
Divorced	5.222**	1.879	1.763	1.122
	(2.849)	(0.941)	(0.941)	(0.673)
Widowed	2.565***	1.035	1.222*	1.006
	(0.408)	(0.134)	(0.107)	(0.084)
Never married	4.045**	0.880	2.352**	0.341**
	(1.916)	(0.403)	(0.748)	(0.140)
Education (1–5 years)	0.732*	0.827	0.950	1.061
Education (>5 years)	0.533**	0.555**	0.662*	0.619**
	(0.123)	(0.112)	(0.115)	(0.110)
High occupation	1.787*	0.571*	0.860	1.313
	(0.451)	(0.137)	(0.266)	(0.370)
Have living child	0.319***	0.716*	0.400***	0.638***
	(0.046)	(0.106)	(0.040)	(0.069)
Main financial source from children	0.134***	0.729*	0.279***	0.523***
	(0.019)	(0.099)	(0.023)	(0.045)
Pension	0.060***	0.496***	0.250***	0.372***
	(0.012)	(0.077)	(0.044)	(0.066)
Sense of control	1.059	0.891*	0.994	0.784***
	(0.058)	(0.041)	(0.033)	(0.025)
Self-reported health	1.170	1.791***	1.095	2.260***
	(0.099)	(0.130)	(0.058)	(0.110)
ADL index	1.169	0.929	1.743***	0.428***
	(0.258)	(0.179)	(0.244)	(0.071)
Cognitive impaired	2.231	0.087	0.585	8.011**
	(3.069)	(0.228)	(0.508)	(5.075)
Proxy	1.263	0.892	0.799**	0.682***
	(0.174)	(0.110)	(0.063)	(0.053)
Constant	0.951	0.551	0.065**	0.021***
	(1.325)	(0.702)	(0.057)	(0.018)
Observations	3,244	3,234	6,607	6,538
Log likelihood	−979.86,126	−1,238.8044	−2,544.3381	−2,594.5301

Standard errors in parentheses

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Additionally, economic stress had both short-term and long-term impact on both the quality of medical care and emotional distress among the oldest-old in 2000 and 2 years after that (results not shown due to space constraint).

Table 3 Estimates for the impact of economic stress on the quality of medical care and the emotional distress of the oldest-old in 2000

Variables	Urban		Rural	
	(1) Poor medicare (odds ratio)	(2) Emotional distress (coef.)	(3) Poor medicare (odds ratio)	(4) Emotional distress (coef.)
Receive welfare	1.276	−0.004	0.532***	0.098***
	(0.383)	(0.029)	(0.093)	(0.018)
No tap water	0.972	0.055*	1.228	0.061***
	(0.260)	(0.023)	(0.167)	(0.014)
Lack of fruits	1.213	0.058***	1.202*	0.047***
	(0.136)	(0.009)	(0.108)	(0.008)
Economic strain	7.388***	0.238***	6.956***	0.291***
	(2.078)	(0.037)	(1.507)	(0.031)
Economic strain × main financial source from children	0.674	−0.127*	0.797	−0.170***
	(0.291)	(0.050)	(0.205)	(0.036)
Age	1.055	−0.001	0.973	−0.001
	(0.031)	(0.003)	(0.018)	(0.002)
Female	1.693	−0.010	0.567***	−0.005
	(0.484)	(0.023)	(0.082)	(0.016)
Minority	1.201	−0.021	0.506*	−0.076**
	(0.573)	(0.040)	(0.143)	(0.026)
Divorced	0.846	0.048	1.336	0.152
	(0.838)	(0.100)	(1.107)	(0.127)
Widowed	0.526*	0.098***	1.712***	0.030*
	(0.135)	(0.021)	(0.249)	(0.015)
Never married	0.073	0.135	0.872	−0.259***
	(0.116)	(0.090)	(0.510)	(0.071)
Education (1–5 years)	0.827	0.017	0.946	0.031
	(0.243)	(0.023)	(0.140)	(0.017)
Education (>5 years)	1.374	−0.058*	0.453*	−0.078**
	(0.531)	(0.029)	(0.150)	(0.027)
High occupation	0.311*	−0.030	2.588*	−0.115*
	(0.163)	(0.031)	(1.016)	(0.046)
Have living child	0.539*	0.019	0.401***	−0.028
	(0.142)	(0.028)	(0.069)	(0.022)
Main financial source from children	0.678	0.001	0.841	0.020
	(0.247)	(0.027)	(0.169)	(0.018)
Pension	0.934	−0.084**	0.589	0.029
	(0.296)	(0.028)	(0.175)	(0.027)
Sense of control	0.757**	−0.083***	1.019	−0.098***
	(0.066)	(0.008)	(0.053)	(0.006)
Self−reported health	2.874***	0.201***	2.369***	0.205***
	(0.413)	(0.013)	(0.191)	(0.010)
ADL index	0.394*	0.098**	1.134	0.153***
	(0.154)	(0.036)	(0.222)	(0.028)
Proxy	0.626	0.057**	1.171	−0.030*
	(0.166)	(0.021)	(0.144)	(0.013)
Constant	0.000***	0.761***	0.111	0.992***
	(0.000)	(0.218)	(0.175)	(0.160)
Observations	2,523	3,204	4,940	6,523

Table 3 continued

Variables	Urban		Rural	
	(1) Poor medicare (odds ratio)	(2) Emotional distress (coef.)	(3) Poor medicare (odds ratio)	(4) Emotional distress (coef.)
Log likelihood	−354.82283	–	−1,079.6553	–
R^2	–	0.21	–	0.20

Standard errors in parentheses

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

11 Economic Stress and Mortality Hazard

We now turn to the relationship between economic stress and mortality. First, we show the Kaplan–Meier survival curves of the probability of survival, against the number of elapsed days from 2000 to 2005 for those who were under economic strain in 2000 with those who were not (see Fig. 3). As can be seen, the probability of survival was higher for those who were not under economic strain and the gap seemed to increase as time advanced. At the end of 5 years, about 46% who were not under economic strain, vs. 42% of those who were, had survived. Log-rank test tells us that there is a statistically significant difference between the two survival curves, with $p > \chi^2 = 0.000$).

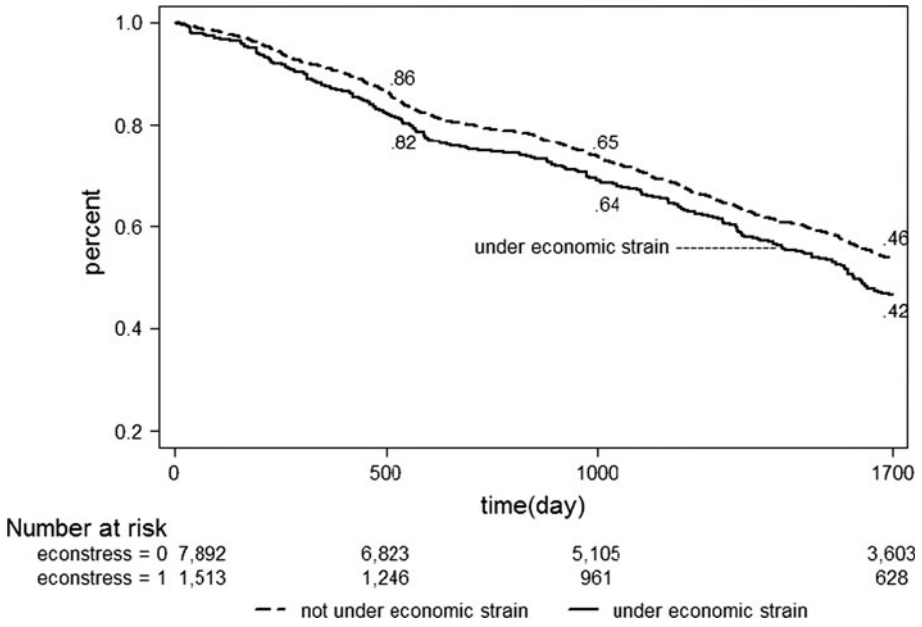

Fig. 3 Kaplan–Meier survival estimates by economic strain, 2000–2005

12 Hazard Models for Mortality

We then show the impact of economic stress on mortality hazard. As the socioeconomic contexts in urban and rural areas are distinct, we conducted separate analysis for urban and rural areas. Tables 4 and 5 show the Cox regression estimates for rural and urban areas respectively. The first model included only the four indicators of economic stress as independent variables. In model 2, we added demographic controls. In model 3, we added moderators, including private social support network, public assistance, life style, and sense of control, and indicators of prior health status. We also added two interaction terms to see if the impact of economic strain changed when the oldest-old had children as his or her main source of income or had access to a pension. Family structure variables were not included in the model because they were highly correlated with whether or not the oldest-old had children as their main source of financial support. In the final model, we further added the two mediators—the quality of medical care and the mental well-being of the oldest-old.

As shown in Table 4, in rural areas, two of the indicators—lack of fruit consumption and perceived economic strain—contributed significantly to a higher mortality hazard. These effects remained rather stable in subsequent models as we added the moderators and mediators. Economic strain and the lack of fruit consumption increased mortality hazard by 40 and 12% respectively in the final model. Having children as main financial source reduced the mortality hazard by about 23% and having pension as a source of income reduced the mortality hazard by 66%. In the final model, the two mediators had reduced the effects of economic strain although only mental distress had a direct impact on the mortality hazard. The control variables were related to mortality rates in expected directions.

In the urban area, a very different picture emerged. All four economic stress indicators were related to a higher mortality hazard but none to a statistically significant level. Having children as a main source of financial support and having pension were not significantly associated with a lower mortality rates. Here the main predictors of mortality rates were the standard demographic (age and gender), socioeconomic status (occupation), health status, and life style indicators. Having a lower sense of control and higher level of mental distress also contributed significantly to a higher mortality rate.

13 Summary and Discussions

We examined the relationship between economic stress, quality of life, and mortality for the oldest-old in China based on data from the Chinese Longitudinal Healthy Longevity Survey conducted between 2000 and 2005. Despite the limitation that we do not have direct measures of family income but only crude measures of economic stress, our findings lend some support to the concern that economic stress is a potentially serious public health issue. We found that the oldest-old in rural areas had significantly poorer quality of life than those in urban areas. They relied more heavily on children and had less access to public assistance than their counterparts in urban areas. Economic stress significantly increased the mortality hazard in rural but not in urban areas. The elderly in rural areas who experienced greater hardships than those in the urban areas had a significantly higher probability of not receiving adequate medical care when needed and of being in greater mental distress. The negative impact of economic strain was ameliorated by the presence of private (children) and public (pension) support networks. Since the public protection

Table 4 Cox regression estimates for mortality hazard in rural areas

Variables	(1) Mortality hazard	(2) Mortality hazard	(3) Mortality hazard	(4) Mortality hazard
Receive welfare	1.037 (0.053)	0.984 (0.051)	1.075 (0.060)	1.151* (0.071)
No tap water	1.033 (0.042)	1.005 (0.041)	1.035 (0.046)	1.005 (0.051)
Never or rarely eat fruits	1.111*** (0.028)	1.117*** (0.028)	1.107*** (0.030)	1.122*** (0.036)
Economic strain	1.247*** (0.059)	1.179*** (0.056)	1.560*** (0.15)	1.397** (0.16)
Economic strain × main financial source from children			0.677*** (0.077)	0.773* (0.10)
Economic strain × pension			0.334*** (0.10)	0.337** (0.14)
Age		1.084*** (0.0052)	1.067*** (0.0057)	1.065*** (0.0066)
Female		0.695*** (0.032)	0.693*** (0.039)	0.750*** (0.048)
Minority		0.905 (0.065)	0.867 (0.070)	0.899 (0.092)
Divorced		1.486 (0.48)	1.352 (0.44)	2.506** (0.84)
Widowed		1.137** (0.051)	1.139** (0.054)	1.126* (0.061)
Never married		0.975 (0.18)	1.093 (0.24)	1.025 (0.26)
Education (1–5 years)		0.965 (0.048)	0.903 (0.048)	0.898 (0.054)
Education (>5 years)		0.989 (0.080)	1.006 (0.087)	1.091 (0.11)
High occupation		1.060 (0.13)	1.036 (0.14)	1.168 (0.17)
Have living child			0.985 (0.067)	0.837* (0.065)
Main financial source from children			1.325*** (0.084)	1.430*** (0.10)
Pension			1.388*** (0.12)	1.536*** (0.15)
Drank			1.120* (0.052)	1.092 (0.059)
Smoked			1.141** (0.057)	1.254*** (0.071)
Exercised			1.047 (0.048)	1.055 (0.055)
Meat, fish, egg consumption			1.178*** (0.056)	1.213*** (0.067)
Sense of control			0.971 (0.018)	0.981 (0.021)

Table 4 continued

Variables	(1) Mortality hazard	(2) Mortality hazard	(3) Mortality hazard	(4) Mortality hazard
Self-reported health			1.234*** (0.037)	1.239*** (0.043)
ADL index			1.839*** (0.13)	1.769*** (0.13)
Cognitive impaired			1.065 (0.41)	1.111 (0.44)
Proxy			1.373*** (0.056)	1.381*** (0.065)
Quality of medical care				1.047 (0.088)
Mental health				1.056 (0.048)
Observations	6,263	6,220	5,803	4,397
Log likelihood	−24,381.121	−24,105.795	−21,681.665	−15,980.741

Standard errors in parentheses

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

system in rural areas is next to non-existent, the impact of economic stress in rural areas is more detrimental to the elderly.

For most of the upcoming generation of elderly in China, relying heavily on children for care is not a viable option. The baby boomer generation who were born in the 1950s grew up under the one-child policy. They have fewer children (and many have no son) to rely on than their predecessors who were the respondents in this study. In addition, the unusually high sex ratio in China as a result of the one-child policy means that there will be fewer daughters and daughters-in-law to perform care giving tasks which have traditionally been the responsibility of females. The shrinking private and public support will pose a great challenge to China's ability to care for its elderly. Although pension reform is under way, a majority of the elderly population still do not have access to these government resources.

Several factors exacerbate the problem of elderly care in China's rural areas: (1) the rural–urban migration of the young population, (2) the substantially higher sex ratio in the rural areas, and (3) the absence of a social security system in the rural areas. As suggested by Li (2007), as rural migrants move to work and live in urban areas, the rural pay-as-you-go pension systems will only exist in name. Currently, the medical system in China is effectively mainly serving those who can afford the high cost. For the elderly who have the highest poverty rates, adequate medical care remains inaccessible. Whether the local governments can set up adequate public safety nets in time to alleviate the pension crisis due to rapid urbanization and whether social security can effectively extend coverage to rural elderly are critical to the well-being of the elderly in China. China's New Rural Cooperative Medical Insurance Scheme (NCMS) established in 2003 is an important effort in this direction. More can be done to ensure the minimum standard of living for the elderly and to build up old-age care agencies and staff, especially for elderly in the rural areas.

Table 5 Cox regression estimates for mortality hazard in urban areas

Variables	(1) Mortality hazard	(2) Mortality hazard	(3) Mortality hazard	(4) Mortality hazard
Receive welfare	1.158	1.128	1.125	1.186
	(0.088)	(0.089)	(0.10)	(0.12)
No tap water	1.090	0.974	0.972	0.956
	(0.073)	(0.066)	(0.072)	(0.079)
Never or rarely eat fruits	1.065*	1.041	1.022	1.037
	(0.030)	(0.030)	(0.032)	(0.036)
Economic strain	1.102	1.109	0.834	0.819
	(0.085)	(0.086)	(0.14)	(0.15)
Economic strain × main financial source from children			1.337	1.445
			(0.25)	(0.31)
Economic strain × pension			1.228	1.192
			(0.28)	(0.30)
Age		1.073***	1.050***	1.046***
		(0.0074)	(0.0082)	(0.0093)
Female		0.745***	0.708***	0.752**
		(0.053)	(0.061)	(0.075)
Minority		1.088	1.089	1.020
		(0.13)	(0.14)	(0.16)
Divorced		1.026	0.928	0.815
		(0.32)	(0.31)	(0.30)
Widowed		1.142	1.177*	1.147
		(0.080)	(0.088)	(0.098)
Never married		0.993	0.791	0.916
		(0.24)	(0.26)	(0.32)
Education (1–5 years)		0.975	1.090	1.158
		(0.071)	(0.085)	(0.10)
Education (>5 years)		0.858	1.023	1.226
		(0.085)	(0.11)	(0.15)
High occupation		0.748**	0.764*	0.766*
		(0.080)	(0.088)	(0.098)
Have living child			0.979	0.966
			(0.093)	(0.10)
Main financial source from children			0.894	0.862
			(0.082)	(0.092)
Pension			0.843	0.829
			(0.087)	(0.099)
Drank			0.911	0.925
			(0.065)	(0.074)
Smoked			1.164*	1.183*
			(0.085)	(0.097)
Exercised			0.752***	0.690***
			(0.048)	(0.050)
Meat, fish, egg consumption			1.044	1.072
			(0.067)	(0.078)
Sense of control			0.930**	0.945
			(0.025)	(0.030)

Table 5 continued

Variables	(1) Mortality hazard	(2) Mortality hazard	(3) Mortality hazard	(4) Mortality hazard
Self-reported health			1.178*** (0.052)	1.131* (0.058)
ADL index			2.534*** (0.23)	2.533*** (0.25)
Cognitive impaired			2.657 (1.36)	2.671 (1.40)
Proxy			1.222** (0.082)	1.187* (0.090)
Quality of medical care				0.894 (0.15)
Mental health				1.221** (0.081)
Observations	2,900	2,880	2,693	2,102
Log likelihood	−9,648.4932	−9,545.3181	−8,460.5736	−6,431.3284

Standard errors in parentheses

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

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