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Early Life Influences on Cognitive Impairment Among Oldest Old Chinese

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Objectives. This article examines the effects of early life socioeconomic conditions on the risk of cognitive impairment among oldest old persons in China. We also examine whether adult socioeconomic status mediates the association between early life socioeconomic status and cognitive impairment in old age.

Methods. Data derived from two waves (1998–2000) of the Chinese Longitudinal Healthy Longevity Survey. We estimated logistic and multinomial regression models of cognitive impairment for a nationwide sample of people aged 80 to 105 ($N = 8{,}444$).

Results. Among both men and women, urban residence in early life as well as education was associated with lower odds of cognitive impairment at baseline. We found modest support for a protective effect of advantaged childhood background on the odds of cognitive impairment onset during the 2-year follow-up, especially among women.

Discussion. Our findings suggest that socioeconomic environment throughout the life course, early life in particular, can influence the risk of cognitive impairment in old age. Not only can public policy that targets illiteracy, hunger, and poverty improve the lives of tens of thousands of children, but ultimately such investments will pay significant dividends many decades later in enhancing the cognitive well-being of older persons.

Key Words**:** Early life conditions—Cognitive impairment—Oldest old—China.

THE World Health Organization estimates that there will be about 29 million demented people worldwide by the year 2020 (Haan & Wallace, 2004), and three quarters of this group will be in developing countries (Prince, 2000). Research over the past two decades in developed countries has emphasized adult risk factors for cognitive impairment (e.g., occupation, social networks, and leisure activities). Only recently has research begun to trace the origin of cognitive functioning in old age to early life conditions (Richards & Deary, 2005). For example, cross-sectional studies of the older population have reported that higher childhood socioeconomic status (SES) is associated with better cognitive functioning (Kaplan et al., 2001; Luo & Waite, 2005; Turrell et al., 2002). Overall, though, little research has examined early life adversity and cognitive impairment in late life, and even less research has investigated the effects of cumulative adversity over the life course on cognitive aging (Haan & Wallace, 2004).

In this study, we examined the association between early life conditions and cognitive impairment among oldest old persons in China. We add to the growing body of literature in this field in a number of ways. First, our focus on China provides a more global perspective on this association. Most existing research is based on data from developed countries, particularly European countries (Kaplan et al., 2001; Singh-Manoux, Richards, & Marmot, 2005; Turrell et al., 2002), with little attention to the childhood origins of adult health problems in developing countries where early life conditions were much worse than those in developed countries in the early part of the 20th century (Campbell, 1997). Many of China's current oldest old individuals suffered from hunger, wars, infectious diseases, and a severe lack of educational opportunities in their childhood (Zeng, Gu, & Land, 2007). It is still an open question whether these types of extremely adverse childhood conditions have left an indelible imprint on cognitive well-being at oldest old ages.

Second, we have taken advantage of a large population-based panel survey to assess whether childhood conditions are associated with both the prevalence and incidence of cognitive impairment at advanced ages. Previous work examining the effects of early life conditions on cognitive functioning has typically been based on small regional samples (Hall, Gao, Unverzagt, & Hendrie, 2000; Wilson et al., 2005) that focused on people younger than 80 (Luo & Waite, 2005; Turrell et al., 2002). And, except for two studies (Everson-Rose, Mendes de Leon, Bienias, Wilson, & Evans, 2003; Hall et al., 2000), previous research has relied on cross-sectional data, preventing an assessment of cognitive decline at advanced ages.

Third, we examined the effect of cumulative socioeconomic disadvantage on the odds of cognitive impairment at baseline and during follow-up. Current understanding of how childhood conditions combine with adult life circumstances to influence cognitive functioning is very limited. Do social disadvantages in early life, particularly those onerous conditions experienced by the Chinese oldest old population, create a life-long deficit in cognitive functioning? Or, do early life disadvantages affect cognitive decline by altering adult trajectories of achievement, which in turn affects cognitive decline in old age?

Increasingly, research on adult health has shown that morbidity, disability, and mortality are hinged to insults from negative events and exposures (e.g., poverty, family distress, unhealthy behaviors, and episodes of illness) that can accumulate over the life course (Kuh & Ben-Shlomo, 1997). Positive effects of experiences such as education and marriage can also accumulate and have lasting beneficial effects on health (Lillard & Waite, 1995; Lund, Holstein, & Osler, 2004; Ross & Wu, 1996). This so-called cumulative advantage/disadvantage model suggests that early advantages/disadvantages can compound over time by setting people onto different life trajectories (e.g., those from advantaged family backgrounds are more likely to enjoy higher levels of education, better jobs, higher income, and stable family relationships), which leads to increasing inequalities in health and well-being as people age (Crystal & Shea, 1990; Ferraro & Kelley-Moore, 2003; O'Rand & Hamil-Luker, 2005).

Although the life course approach is conceptually appealing, researchers' understanding of the specific mechanisms linking early life conditions and late-life cognition is fragmentary. Two perspectives, the *latency model* and the *pathway model*, potentially provide some insights into these mechanisms. The latency model suggests that early life circumstances have a direct association with late-life health outcomes such as cognitive impairment. Early life adversity can lead to fewer initial cognitive resources (i.e., less reserve) because the brain grows most during the prenatal period and the first 3 years of life and continues to grow in childhood and adolescence (Kim, Stewart, Shin, & Yoon, 2003). Impaired development of the brain due to early nutritional deprivation can result in less efficient brain function because of "less myelin, less branching of dendrites, and less developed connectivity patterns" (Moceri, Kukull, Emanuel, van Belle, & Larson, 2000, p. 415), although the brain can still function normally. The negative effects of the impaired brain development may be small until aggravated by the aging process (Moceri et al., 2000). A growing body of research has reported that early life nutritional deprivation is associated with small head size, short arm length and height, cognitive impairment, and dementia in later life (Jeong et al., 2005). If the latency model holds, early life adversity should be associated with poor cognitive functioning after one controls for what happens in adulthood.

The pathway model suggests, however, that early life circumstances may indirectly influence cognitive impairment via education attainment, occupational exposures and challenges, and illness. A large body of research across different countries has reported an inverse relationship between education and late-life cognition as measured by cognitive tests, cognitive decline, cognitive impairment, or dementia (e.g., Cagney & Lauderdale, 2002; M. Y. Zhang et al., 1990). The literature points to two explanations for the education–cognition link: (a) The rich environment in schools promotes brain growth in formative years and enables the brain network to operate more efficiently, thus providing a reserve against cognitive decline (Kaplan et al., 2001); and (b) education leads to mental stimulation throughout the life course because higher levels of education often lead to occupations that involve cognitive challenges and practice (Andel, Kareholt, Parker, Thorslund, & Gatz, 2007; Hauser & Roan, 2007; Schooler, 1987; Schooler, Mulatu, & Oates, 1999). In addition, poor early life conditions can increase the risk of several chronic conditions in adulthood, which in turn affects late-life cognitive functioning (Turrell et al., 2002). Those conditions that are frequently linked with cognitive impairment include hypertension, heart disease, and stroke (National Research Council, 2000). According to the pathway model, then, the association between early life adversity and cognitive impairment should be attenuated when adult SES and health are controlled. In sum, the origin of cognitive impairment in old age is most likely complex and multifactorial. Research over the past 20 years has pointed increasingly to the role of early life environments in the development of cognitive impairment and dementia.

In this article, we draw on two waves (1998–2000) of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) to study the association between early life circumstances and cognitive impairment in oldest old Chinese. On the basis of cumulative advantage and disadvantage theory and results from previous research, we evaluated the following hypotheses. First, early life SES disadvantage would be associated with increased odds of cognitive impairment at baseline and onset over the 2-year follow-up. Second, the effect of early life environment on cognitive impairment would be partially mediated via adult SES and other adult factors. Third, those who were disadvantaged in both childhood and adulthood would be more likely to have cognitive impairment compared to those from advantaged backgrounds.

Methods

Data

The CLHLS has a panel design with baseline data collected in 1998 and follow-up surveys in 2000, 2002, and 2005 (to be released in 2007). We made use of only the first two waves (1998 and 2000) because the wording of one question was slightly changed and five additional questions were inserted into the cognitive function section in the 2002 wave, which may have affected response patterns. The CLHLS was conducted in 631 randomly selected counties/cities of 22 Chinese provinces (there are 31 provinces in mainland China). The surveyed areas covered about 85% of the total Chinese population. Local aging committees provided name lists of centenarians in randomly selected counties/cities. For each centenarian with a predesignated random code, one nearby octogenarian and one nearby nonagenarian with predesignated age and gender were randomly selected and interviewed. The term *nearby* refers to the same village or street—or the same town, county, or city—when applicable. This sampling strategy is designed to ensure comparable numbers of randomly selected male and female octogenarians and nonagenarians at each age from 80 to 99. In spite of its complex design, the sampling strategy is random in its nature. Therefore, the CLHLS is representative of the Chinese oldest old population in 22 provinces. A more detailed description of the sampling design and data quality of the CLHLS appears elsewhere (Zeng, Vaupel, Xiao, Zhang, & Liu, 2001).

This study focused on 8,805 respondents aged 80 to 105 in 1998. Those who reported being aged 106 or older were excluded because of insufficient information to validate their advanced age (Zeng & Vaupel, 2002). Out of the 8,805 baseline interviewees, 4,691 (53.3%) survived and were reinterviewed, whereas 3,264 (37.1%) died and 850 (9.6%) were lost to follow-up in the second wave in 2000. The CLHLS is the largest longitudinal survey of the oldest old population ever conducted in a developing country.

Measures

Cognitive impairment.—The CLHLS measures cognitive function using the Chinese version of the Mini-Mental State Examination (MMSE). The MMSE was adapted from Folstein, Folstein, and McHugh (1975) and tests four aspects of cognitive functioning: orientation, calculation, recall, and language. On the whole, most items could be translated without modification. Several items were modified to meet the cultural and socioeconomic conditions in China and to make the questions easily understandable and practically answerable among oldest old Chinese whose cognitive function is normal. For example, the respondents were asked to name as many foods as possible instead of to write a sentence, which is an impossible task for members of this age group, the majority of whom are illiterate. The calculation question was also simplified (Zeng & Vaupel, 2002). Several similar versions of the Chinese MMSE, all of which were adapted from Folstein and colleagues (1975), are reliable and valid for use with Chinese older persons (Yu et al., 1989; Z. X. Zhang et al., 2006). The total possible score on the MMSE is 30, with lower scores indicating poor cognitive ability. Consistent with previous studies, the number of responses of "unable to answer" was much higher for the relatively difficult tasks compared with the relatively easy tasks. Based on recommendations in the literature, we counted responses of "unable to answer" as incorrect answers (Herzog & Wallace, 1997). For the current sample, the reliability of the MMSE scale was high (Cronbach's $\alpha = .94$). Respondents were defined as having moderate–severe cognitive impairment (hereafter *cognitive impairment*) in 1998 if their scores on the MMSE were less than 18 (Nguyen, Black, Ray, Espino, & Markides, 2003; Yu et al., 1989); respondents were considered to be experiencing the onset of cognitive impairment if their MMSE score fell below 18 during the 2-year follow-up among those whose initial MMSE scores were 18 or higher. The choice to use 18 as a cutoff point was due to previous research findings that those individuals who scored less than 18 had a very high probability of being cognitively impaired, regardless of education (Folstein et al., 1975; M. Y. Zhang et al., 1990). Previous clinical studies in China have also validated the use of 18 or 19 as a cutoff point for screening dementia among populations with little or no formal education (M. Zhang et al., 1998; Z. X. Zhang et al., 2006). We also found that our results were insensitive to varying the cutoff point up or down by one unit.

We examined the prevalence of cognitive impairment at baseline to document how early life and adult conditions affect the cognitive status of persons surviving to advanced ages. These persons, especially in a developing society such as China, represent the most robust of their birth cohorts. Prevalence reflects the stamp of the cognitive aging process that occurred prior to baseline on the surviving old-age population. The dependent variable in the prevalence model was a dichotomous variable, with cognitive impairment coded as 1. Onset between 1998 and 2000 refers to new events of cognitive impairment among those without impairment at baseline. To the extent that much of cognitive aging occurs prior to baseline, leaving behind a highly robust group of elders, examining incidence among oldest old persons offers a conservative approach to assessing the consequences of early life on the cognitive aging process. Admittedly, however, the number of events identifying the onset of cognitive impairment in our analysis was relatively small (247 events among men vs 528 events among women), which also points to the conservative evaluation of hypothesized effects. To take account of competing risks, the dependent variable in the incidence model had four outcomes: cognitive impairment, death, loss to follow-up, and cognitively normal (the base category).

Our analytic sample for the prevalence model included 8,444 respondents. This reflected the elimination of 361 respondents who did not participate in the cognitive tests due to various reasons including sickness, refusal, or hearing or vision impairment. There were 6,475 (76.7%) oldest old persons out of 8,444 respondents who did not suffer from cognitive impairment at baseline according to the above criterion (MMSE score ≥ 18). Of 6,475 respondents in the incidence model, 775 (12.0%) experienced the onset of cognitive impairment, 1,886 (29.1%) died, 711 (11.0%) did not participate in the 2000 survey, and the remaining 3,103 (47.9%) maintained relatively normal cognitive functioning.

Early life SES.—The CLHLS defines childhood as the period from birth to age 14. Early life conditions are indexed by three variables: place of birth, whether the respondent frequently went to bed hungry in childhood, and education. A proxy (i.e., spouse or a close family member) participated when the respondent was unable to answer some questions due to various reasons (e.g., cognitively impaired and could not understand the question). Approximately 20% of respondents had at least one proxy answer among the three childhood SES indicators. Place of birth was collected in the survey in terms of urban or rural area. Tremendous gaps in standard of living and health care existed between urban and rural areas, with rural areas disadvantaged in early 20th-century China where many of the oldest old participants were born and raised (Zeng et al., 2007). Rural/urban residence at birth thus reflected general individual as well as community socioeconomic conditions of the respondent's childhood. We dichotomized responses to the item about frequently going to bed hungry in childhood (went to bed without hunger = 1). This measure reflected both poverty as well as early nutritional deprivation.

We considered educational attainment mainly as an indicator of childhood SES, although it is arguably a measure that can reflect adult SES. We based our choice on the fact that whether one had schooling is a strong indicator of childhood SES among the oldest old Chinese because when most of them were children, the vast majority of schools in China were private (Kuo, 1915), and only those families who had enough resources could afford to send their children to schools (Zeng et al., 2007). In our sample, about 37% of men and 87% of women had no schooling, 46% of men and 10% of women had some elementary education, and less than 17% of men and 3% of women had a middle-school education or higher education. Therefore, we dichotomized the education variable into had schooling (coded 1) and no schooling.

Adult SES.—Adult SES was measured by respondents' primary lifetime occupation before age 60 and current residence (urban = 1). We classified own occupation into two categories: professional/administration and other low-SES job. Researchers

Table 1. Sample Distribution of Variables by Gender

Variable	Men	Women
Childhood SES (%)		
Born in urban	16.33	14.69
Went to bed without hunger	45.48	43.19
Received 1+ years schooling	63.31	13.18
Adulthood SES (%)		
Professional/administration	18.66	3.92
Living in urban	40.06	36.55
Other adulthood covariates		
Currently married (%)	35.48	5.81
No. of children who frequently come to visit (0–5)	2.23	1.69
Gardening (%)	12.92	5.53
Playing cards/mah-jongg (%)	17.45	9.62
Listening to radio/watching TV (%)	63.25	45.33
Disabled in activities of daily living (%)	25.93	41.29
Demographic		
Age (years)	89.81	93.10
Cognitive impairment (%)	12.11	30.44
n	3,467	4,977

Note: Data are from the Chinese Longitudinal Healthy Longevity Survey, 1998. $N = 8,444$. Means and percentages are unweighted. SES = socioeconomic status.

frequently use urban residence as a major indicator of SES among Chinese elders due to the sharp divide between urban and rural areas in income, health care, school quality, access to public goods such as housing, sanitation, and other dimensions of welfare (e.g., Liang et al., 2000; Zhu & Xie, 2007). Although current residence could potentially differ from the primary residence during adulthood, we expected a negligible difference because the household registration system established in 1955 limited rural–urban migration (Li, 2005). The pilot reform of the household registration system started only a couple of years ago, and the oldest old population is the least likely adult age group to migrate.

Other adult conditions.—We included marital status (married = 1), number of children who frequently come to visit (0–5), involvement in leisure activities, and disability in 1998 in our incidence model; except for marital status, we did not include these measures in the prevalence model due to possible endogeneity. Measures of leisure activities (i.e., gardening, playing cards/mah-jongg, listening to radio/watching TV) were dichotomized, with 1 = everyday/sometimes and 0 = never. Disability was measured in terms of six functional problems: bathing, dressing, toileting, indoor transferring, maintaining continence, and eating. If respondents needed help in one or more items, we classified them as disabled.

Control variables.—Age was measured as a continuous variable.

Analytic Strategies

We estimated gender-specific models because previous research on early life influences on late-life health has suggested that early life risk factors may operate differently for men and women (Best, Hayward, & Hidajat, 2005; Kim et al., 2003). In the prevalence model, we used binary logistic regression to model how early life conditions were associated with the probability of being cognitive impaired at baseline. We first estimated a reduced form model to identify the total effect of early life SES on the odds of having cognitive impairment and then estimated an expanded model to determine whether the effect was reduced after we introduced adult SES. If the effect of early life SES is substantially reduced, this would lend support to the pathway model whereby early life SES indirectly affects the probability of cognitive impairment. If the effect of early life SES is not reduced, this would lend support to the latency model and suggest that early life SES may have a direct effect on cognitive impairment.

We modeled the onset of cognitive impairment over a 2-year observation period using multinomial logistic regression. These models included death and attrition as competing risks, as death and attrition may preempt the observation of the onset of cognitive impairment, and these processes were likely to be linked to cognitive functioning problems. We adopted a nested modeling strategy to evaluate the spectrum of associations of early life and adult SES with the onset of cognitive impairment. We first examined how early life conditions (i.e., rural/urban residence at birth and hunger at bedtime in childhood) affected the onset of cognitive impairment controlling for age (Model 1), and then we added educational attainment (Model 2), adult SES (Model 3), and other adult risk factors (Model 4). Finally, we added respondents' MMSE scores at baseline as a covariate and examined whether cognitive functioning differences among nonimpaired persons affected our results (Model 5). Because the sampling weights in the data set are solely a function of major independent variables (i.e., age, gender, and rural/urban residence) used in the analysis, the unweighted estimates are preferred because they are unbiased, are consistent, and have smaller standard errors than weighted estimates (Winship & Radbill, 1994). We performed all analyses using Stata Version 10.0 (StataCorp, 2007). The tables reporting the results of the logistic regression models express the effects in terms of relative odds.

Results

Descriptive Results

Table 1 presents the sample distribution of the variables used in the study. As is evident, the prevalence of cognitive impairment differed for men and women. About 12% of men in our analytic sample were cognitively impaired at baseline compared to more than 30% of women. Most respondents had been born in rural areas, with only 16% of male and 15% of female respondents born in urban areas. About 45% of men and 43% of women reported that they had not frequently suffered from hunger before going to bed in childhood. As for level of educational achievement, the gender gap was enormous: Only 13% of women had received some education compared to 63% of men.

A minority of respondents had once held professional/administrative jobs before age 60. However, nearly 40% of men and 37% of women lived in urban areas at the time of the survey. As expected, most oldest old participants were widowed. On average, about two nonresident children visited respondents frequently. As for leisure activities, more men than women

Table 2. Early Life Influences on the Odds of Cognitive Impairment Among Oldest Old Chinese

Variable	Model 1	Model 2	Model 3
Men (n = 3,467)			
Childhood SES			
Born in urban (ref: rural)	0.39** (0.08)	0.44** (0.10)	0.44** (0.10)
Went to bed without hunger (ref: with hunger)	0.92 (0.10)	1.00 (0.11)	1.00 (0.11)
Received some schooling (ref: no schooling)		0.60** (0.07)	0.60** (0.07)
Adulthood SES			
Professional/administration (ref: other)			0.88 (0.16)
Living in urban (ref: rural)			1.03 (0.13)
Control variables			
Married (ref: unmarried)	0.67** (0.09)	0.67** (0.09)	0.68** (0.09)
Age	1.12** (0.01)	1.12** (0.01)	1.12** (0.01)
–Log pseudo-likelihood	1,133.3	1,122.7	1,122.5
Women (n = 4,977)			
Childhood SES			
Born in urban (ref: rural)	0.66** (0.07)	0.73** (0.08)	0.80† (0.09)
Went to bed without hunger (ref: with hunger)	0.85* (0.06)	0.87* (0.06)	0.88† (0.06)
Received some schooling (ref: no schooling)		0.62** (0.08)	0.66** (0.08)
Adulthood SES			
Professional/administration (ref: other)			0.85 (0.20)
Living in urban (ref: rural)			0.81** (0.06)
Control variables			
Married (ref: unmarried)	0.60* (0.14)	0.62* (0.14)	0.62* (0.14)
Age	1.14** (0.01)	1.14** (0.01)	1.14** (0.01)
–Log pseudo-likelihood	2,628.2	2,620.7	2,616.5

Notes: Data are from the Chinese Longitudinal Healthy Longevity Survey, 1998. N = 8,444. Numbers in parentheses are robust standard errors of the logistic regression parameter estimates. SES = socioeconomic status.

$^{\dagger}p < .1$; $*p < .05$; $**p < .01$.

were involved in gardening, playing cards or mah-jongg, and listening to radio or watching TV. Part of the gender differences in leisure activities may have been due to gender differences in disability. About 41% of women were disabled compared to 26% of men.

Early Life Influences on the Prevalence of Cognitive Impairment

The results in Table 2 show that for both men and women, markers of early life SES advantage were significantly associated with lower odds of cognitive impairment. In Model 1, oldest old men born in urban areas had a 61% lower risk of being cognitively impaired; oldest old women born in urban areas had a 34% lower risk of being cognitively impaired compared to those born in rural areas, controlling for marital status and age. Freedom from frequent hunger appeared to have a slightly protective effect for women but was not associated with cognitive impairment for men. When education was added to Model 1 (see Model 2), the protective effect of birth residence was slightly attenuated; however, the change was not statistically significant. Comparing Models 1 and 2 we can conclude that (a) education lowered the risk of cognitive impairment by 40% for men and 38% for women, and (b) the protective effect of urban birth was not attributable to education. Instead, childhood birth place and education had independent effects on the odds of cognitive impairment. When adult SES was included in Model 3, the associations between early life SES and cognitive impairment continued to be robust. In addition, neither occupation nor urban residence in adulthood was associated with the odds of cognitive impairment among men. However, among women, adult urban residence reduced the odds of cognitive impairment, net of early life conditions and demographic controls. In additional analyses (results not shown), we estimated a model including only adult SES and demographic controls. We found that without controlling for childhood SES, adult occupation was significantly associated with the odds of cognitive impairment for both men and women. For example, men and women who had worked in professional/administrative jobs were 33% and 38% less likely, respectively, to have cognitive impairment than those employed in lower SES jobs. However, although adult SES was associated with the probability of being cognitively impaired, the association seemed spurious because early life SES influenced both adult SES and cognitive impairment. This result was largely consistent with findings from prior studies in developed countries (e.g., Cagney & Lauderdale, 2002; Karp et al., 2004).

To gain a better handle on the substantive consequences of how multiple resources, when combined, affect cognitive functioning, we estimated the odds ratios of having cognitive impairment for those who were in the most advantaged childhood and adult SES positions versus those who were in the most disadvantaged childhood and adult SES conditions, controlling for marital status and age. Our estimates were based on the results in Model 3 of Table 2. For men, those who were the most advantaged (i.e., born in urban areas, did not frequently go to bed hungry, had some schooling, had a professional/

Table 3. Early Life and Adult Influences on the Onset of Cognitive Impairment Among Oldest Old Chinese Men

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Childhood SES					
Born in urban (ref: rural)	0.78 (0.16)	0.84 (0.18)	1.03 (0.22)	1.02 (0.22)	1.03 (0.23)
Went to bed without hunger (ref: with hunger)	0.83 (0.12)	0.87 (0.13)	0.88 (0.13)	0.90 (0.13)	0.90 (0.13)
Received some schooling (ref: no schooling)		0.75† (0.11)	0.80 (0.12)	0.83 (0.13)	0.86 (0.13)
Adulthood SES					
Professional/administration (ref: other)			0.81 (0.20)	0.83 (0.20)	0.85 (0.21)
Living in urban (ref: rural)			0.67* (0.11)	0.66* (0.11)	0.65* (0.11)
Other adulthood conditions					
Married (ref: unmarried)				1.15 (0.19)	1.16 (0.19)
No. of children who frequently come to visit (0–5)				0.96 (0.04)	0.96 (0.04)
Gardening (ref: no)				0.65** (0.11)	0.66* (0.11)
Playing card/mah-jongg (ref: no)				0.77 (0.16)	0.79 (0.17)
Listening to radio/watching TV (ref: no)				0.77† (0.12)	0.79 (0.12)
Disabled in activities of daily living (ref: none)				1.85** (0.33)	1.76** (0.32)
Control variables					
Age	1.12** (0.01)	1.12** (0.01)	1.12** (0.01)	1.10** (0.01)	1.10** (0.01)
Baseline cognitive score					0.95* (0.02)
–Log pseudo-likelihood	3,321.2	3,315.0	3,271.5	3,191.9	3,176.9

Notes: Data are from the Chinese Longitudinal Healthy Longevity Survey, 1998–2000. $N = 3{,}027$. Numbers in parentheses are robust standard errors of the multinomial regression parameter estimates. SES = socioeconomic status.

†$p < .1$; *$p < .05$; **$p < .01$.

administrative job, and currently lived in urban areas) had a 76% (odds ratio $= 0.44 \times 1.00 \times 0.60 \times 0.88 \times 1.03 = 0.24$) lower probability of being cognitively impaired at baseline than their most disadvantaged counterparts (i.e., born in rural areas, frequently went to bed hungry, had no schooling, had a low-SES job, and currently lived in rural areas). Among the oldest old women, those who were in the most advantaged SES position in childhood and adulthood had a 68% (odds ratio $= 0.80 \times 0.88 \times 0.66 \times 0.85 \times 0.81 = 0.32$) lower probability of having cognitive impairment than those in the most disadvantage positions.

Early Life Conditions and the Onset of Cognitive Impairment

The incidence models shown in Tables 3 (men) and 4 (women) show that better early life conditions also appeared to offer some modest protection against the onset of cognitive impairment, especially for women. Among men, the effects of

Table 4. Early Life and Adult Influences on the Onset of Cognitive Impairment Among Oldest Old Chinese Women

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Childhood SES					
Born in urban (ref: rural)	0.68* (0.11)	0.73† (0.12)	0.72† (0.12)	0.72† (0.12)	0.77 (0.13)
Went to bed without hunger (ref: with hunger)	0.83† (0.09)	0.85 (0.09)	0.85 (0.09)	0.86 (0.09)	0.88 (0.10)
Received some schooling (ref: no schooling)		0.70* (0.12)	0.69* (0.12)	0.77 (0.14)	0.82 (0.15)
Adulthood SES					
Professional/administration (ref: other)			1.10 (0.39)	1.21 (0.43)	1.23 (0.44)
Living in urban (ref: rural)			1.02 (0.12)	0.98 (0.12)	1.00 (0.12)
Other adulthood conditions					
Married (ref: unmarried)				0.62† (0.16)	0.63† (0.16)
No. of children who frequently come to visit (0–5)				0.94* (0.03)	0.95 (0.03)
Gardening (ref: no)				0.68* (0.10)	0.70* (0.11)
Playing card/mah-jongg (ref: no)				0.59** (0.11)	0.64* (0.12)
Listening to radio/watching TV (ref: no)				0.84 (0.09)	0.91 (0.10)
Disabled in activities of daily living (ref: none)				1.64** (0.20)	1.47** (0.18)
Control variables					
Age	1.09** (0.01)	1.09** (0.01)	1.09** (0.01)	1.07** (0.01)	1.06** (0.01)
Baseline cognitive score					0.89** (0.01)
–Log pseudo-likelihood	4,035.1	4,020.9	4,006.1	3,945.9	3,908.2

Notes: Data are from the Chinese Longitudinal Healthy Longevity Survey, 1998–2000. $N = 3{,}448$. Numbers in parentheses are robust standard errors of the multinomial regression parameter estimates. SES = socioeconomic status.

†$p < .1$; *$p < .05$; **$p < .01$.

early life SES were in the expected direction, although none were statistically significant at the $p < .05$ level (see Models 1 and 2 of Table 3). Results in Model 3 of Table 3 show that current residence was statistically associated with onset: Men living in urban areas were 33% less likely to experience onset compared to those in rural areas. Adult occupation was not significantly associated with onset of cognitive impairment. Among women, Model 1 of Table 4 shows that women born in urban areas were 32% ($p < .05$) less likely to experience onset than their counterparts born in rural areas. Freedom from hunger reduced the risk by 17% ($p < .1$). Model 2 shows that those who had received some schooling were 30% ($p < .05$) less likely to experience onset compared to those who had received no schooling. When adult SES was added in Model 3, the results showed very little attenuation of the protective effects of early life conditions for women.

Model 4 of Tables 3 and 4 introduced marital status, children's visits, leisure activities, and activity of daily living disability for men and women, respectively. The effects of women's early life conditions on the risk of cognitive impairment were largely undisturbed except for the effect of education, which was no longer statistically significant. Finally, we included respondents' baseline cognition scores in Model 5 for men and women to see whether they would affect the association between early life SES and the risk of cognitive impairment. The results showed that although baseline cognitive scores were significantly associated with the odds of having cognitive impairment during the follow-up, the effects of early life SES and other covariates were largely undisturbed. As for the associations between early life SES and the competing risk of death and loss to follow-up, due to space limitations, we did not include the results in Tables 3 and 4, but they are available upon request. In additional analyses (results not shown), we also tested the effects of other early life factors on the risk of cognitive impairment, including father's occupation, parental survivorship at respondent's age 10 or 15, and number of sibling. We observed no significant net effects.

To gain some substantive sense of how early life SES combines with adult SES to influence the onset of cognitive impairment, we calculated the odds ratios of having cognitive impairment for those who were in the most advantaged childhood and adult SES positions versus those who were in the most disadvantaged conditions, controlling for age only. The calculations were based on results from Model 3 of Tables 3 and 4. For men, the odds of onset during the 2-year follow-up were 61% ($1.03 \times 0.88 \times 0.80 \times 0.81 \times 0.67 = 0.39$) lower for those who were most advantaged in both childhood and adulthood than for those who were disadvantaged throughout life. Among oldest old women, the pattern was similar. The odds of onset were 53% ($0.72 \times 0.85 \times 0.69 \times 1.10 \times 1.02 = 0.47$) lower for those who were most advantaged in both childhood and adulthood than for those who were most disadvantaged all their lives.

Discussion

Our analysis documents that childhood SES is associated with the prevalence and incidence of cognitive impairment for both men and women reaching advanced ages. Education and early life urban residence are protective against having cognitive impairment at baseline. The protective effect of early life urban residence is consistent with results of prior studies that showed a negative association between childhood residence in areas characterized with higher SES levels and the risk of Alzheimer's disease (e.g., Hall et al., 2000; Moceri et al., 2000). Although our data did not allow us to examine the specific reasons behind the protective effects of childhood urban residence, we suspect that they relate to the higher standard of living in urban areas (including presence of health facilities and access to information) as compared to rural areas during the early 20th century in China. We also found that frequent hunger was associated with women's higher risk of cognitive impairment but not men's. The reason for this is not clear. Due to the low status of girls in traditional Chinese families, we suspect that if a family had both girls and boys (as most Chinese families did at that time), undernutrition would be more severe among girls than boys because sons were often favored and given better food (Watson, 1991). However, we found only modest support for the protective effect of advantaged childhood background on the odds of impairment onset, and the effect seemed to be stronger for women than men. Overall, our results suggest that having socioeconomic advantages over the entire life course offers the greatest protection from cognitive impairment.

As for the mechanisms linking early life SES and the risk of cognitive impairment, we found relatively strong support for the latency model and only modest support for the pathway model. Our results suggest that early life conditions are directly associated with the risk of cognitive impairment in old age. For instance, in our prevalence models, the magnitude and significance of the effect of rural/urban residence at birth and education changed very little with the addition of adult SES and other risk factors. The support for the pathway model is very modest, as can be seen from the slight attenuation of the effect of early life SES when adult factors were included.

This study has several strengths, including a large nationwide sample of oldest old persons in a developing country, the use of longitudinal data, and an exploration of the mechanisms linking early life SES and cognitive impairment. However, readers should consider several limitations when interpreting the results. First, a brief epidemiological screening instrument (MMSE) for cognitive impairment rather than comprehensive clinical evaluations was used to detect cognitive impairment. Clinical evaluations are usually more accurate. Due to budget limitations, the CLHLS did not conduct clinical tests. Second, our measures of early life conditions were relatively crude. Although childhood residence, education, and frequent hunger before going to bed captured major aspects of economic hardship in childhood, we could not identify the extent of poverty and nutritional deprivation, or the timing and duration of hunger. Third, our measures of adult SES were also relatively crude. We lacked detailed information about the characteristics of the respondents' occupation and financial resources. Fourth, our measures of early life conditions were based mainly on self-reports, and as with other studies that have used self-reports, there is the potential problem of recall bias, especially among those who are cognitively impaired. Finally, a caveat in interpreting the results is that our sample of oldest old individuals was a select group of robust survivors of much political, economic, and social unrest that had occurred in 20thcentury China. They had survived Japanese invasion in the mid-1930s, numerous internal wars, famines (e.g., the 1959–1961 famine), and the Cultural Revolution (1966–1976). We suspect that our estimates of the impact of early life SES may be conservative due to selective mortality, because previous research in China has found that people with poor early life SES and/or adult SES are more likely to die than their advantaged counterparts (Liang et al., 2000; Zeng et al., 2007).

Despite these limitations, our study contributes to the ongoing discussion on early life conditions and late-life cognitive well-being. We found support for the hypothesis that the onset of cognitive impairment in old age may have an early origin. From a policy perspective, our study suggests that interventions should focus on the entire life course, and the formative years in particular. We found that even for the robust oldest old Chinese, early life conditions can protect against cognitive impairment and thus significantly improve the quality of life in old age. Not only can public policy in developing countries that targets illiteracy, hunger, and poverty improve the lives of tens of thousands of children, but ultimately it appears that such investments will pay significant dividends many decades later in enhancing the cognitive well-being of older persons.

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Demographic Change, Fiscal Sustainability, and Macroeconomic Performance

David E. Bloom
David Canning

Debates over the economic effects of demographic change have been raging for over 200 years. Since Thomas Malthus hypothesized in 1798 that rapid population growth would stretch the earth's resources beyond the breaking point, leading to mass starvation and death, demographers and economists have argued: first, about whether this would come to pass, and then, about why it did not. More recently, discussions about population size have given way to theories suggesting population age structure and health status are key demographic determinants of economic progress.

In this brief summary of the impacts of demographic change on macroeconomic performance, we first set out some key facts about world population. We discuss the effects of improvements in population health on economic growth in general, before focusing more specifically on demographic effects. We then trace the history of how Malthusian pessimism gave way to population "optimism," which argued that rapid population growth could be an economic asset, and then to a "neutralist" view, which posited that population growth neither promoted nor impeded economic growth. Next, we examine how new

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Global Aging and the Demographic Divide

Carl Haub

In the latter half of the last century, the world's developed' nations completed a long process of demographic transition. The field of demography describes this demographic transition as a shift from a period of high mortality, short lives, and large families to one with a longer life expectancy and far fewer children. This transformation took many centuries in Europe and North America as people moved from farms to cities; basic public health measures steadily reduced the risk of contagious disease; and modern medicine prolonged lives to unprecedented lengths. In developing countries, this demographic transition is certainly underway, though these countries vary widely at their places along the spectrum.

Very low birth rates and the resultant population decrease have received considerable media attention, particularly in Europe and parts of eastern Asia. In the past, when demographers projected national and global populations, the projections commonly assumed that birth rates would decline worldwide but only to the "two-child" family, i.e., two children per woman or per couple on average. An assumption that fertility would fall below this rate would have some unpleasant consequences: a decrease in population size and a population top-heavy with retired seniors who would depend upon the social taxes paid by a dwindling number of younger workers. While it may

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