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Socioeconomic Differentials in Mortality Among the Oldest Old in China

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Although an inverse relationship between socioeconomic status (SES) and mortality has been well documented for many populations throughout the world, it remains unclear whether this relationship holds true for the oldest old. Most notably, some scholars have suggested that the relationship may disappear at the oldest ages. Using data from the 1998, 2000, and 2002 waves of the Chinese Longitudinal Healthy Longevity Survey, this study examined the relationship between SES and mortality among the oldest old (80 years and older) population in China. The results show the continuing prevalence of SES differentials in mortality—higher SES is significantly associated with lower mortality risks—among the oldest old in China. The authors further show that the relationship holds regardless of how the oldest old are operationalized (as 80 years and older, 90 years and older, or 100 years and older).

Keywords: *socioeconomic status; mortality; oldest old; China*

Over the past five decades, numerous studies have explored the relationship between mortality and socioeconomic status (SES; e.g., see Bassuk, Berkman, and Benjamin 2002; Kitagawa and Hauser 1973; Shkolnikov et al. 1998). In one of the earliest studies, Moriyama and Guralnick (1956) examined occupational differentials in mortality in the United States and found substantial differences between laborers and nonlaborers (see the review by Moore and Heyward 1990). Since that seminal study, researchers have extended the depth and scope of their inquiry by incorporating multiple SES

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measures and by examining mortality patterns across nations. Kitagawa and Hauser (1973), for example, considered mortality differentials by both educational and income levels, relying on data matched between the 1960 U.S. census and death certificates. In the early 1980s, the *Black Report* examined occupational differentials in health and mortality in England (Black et al. 1982). A prevailing view has emerged from these studies: there is an inverse relationship between SES and mortality (Robert and House 2000; Williams 1990).

Despite the consistency of this finding in almost all past studies, two qualifications have emerged. First, the causal nature of the relationship between SES and mortality is less than clear. Prior factors, such as a preexisting medical condition, could account for the observed association between low SES outcomes and heightened mortality risks. However, the large extant literature in this area suggests that the relationship between SES and health inequality is primarily causal (Adler and Ostrove 1999; Goldman 2001). Second, the strength of this relationship may vary across populations and social contexts. In particular, whether this relationship holds true for the elderly population has been questioned. This study focused on the latter concern, assessing the extent to which the prevailing wisdom concerning the SES-mortality relationship holds for the oldest old population in China. Although a strong inverse relationship between SES and mortality has been well documented for the adult population (see, e.g., Moriyama and Guralnick 1956), studies that focus on the elderly population (65 years and older) have produced far less consistent results, and even these studies have not adequately explored the oldest old population (80 years and older).

Two primary hypotheses have been advanced to describe the age pattern in the relationship between SES and mortality and health: the cumulative advantage and the convergence hypotheses. The cumulative advantage hypothesis predicts that the effect of SES (i.e., the SES gap) grows larger with age. According to Ross and Wu (1996), "educational attainment increases resources that accumulate throughout life, producing a larger SES gap in health among older persons than younger" (p. 105). However, except for their study, the current literature does not offer much evidence to substantiate this hypothesis.

In contrast, the convergence hypothesis asserts that the effect of SES begins small on health in early adulthood, expands in middle age, and then narrows in old age (House et al. 1994). This perspective predicts that the magnitude of this relationship at very old ages is minimal or even nonexistent. A number of factors might explain such an age pattern of convergence (House et al. 1990, 1994). First, the oldest old are clearly detached from economic activities and thus immune to some causal mechanisms through which SES affects mortality, such as job hazards and work stress. Second, with age, biological determinants may become more important in determining health, gradually dominating social factors in affecting mortality for the oldest old. Third, the diminished or nonexistent SES differentials in older ages may reflect the fact that less healthy people have died prior to certain old ages. In other words, those who survive to very old ages are already selected with respect to unobserved health traits that should compensate for SES effects. Fourth, the exposure to health risk through unhealthy behaviors such as smoking and drinking is reduced among the elderly. Finally, in developed countries such as the United States, social welfare policies reduce SES inequalities among the elderly.

In support of the convergence hypothesis, several studies have found evidence suggesting that the effect of SES on health and mortality is smaller for the elderly than for adults (aged 25 to 64 years; Backlund, Sorlie, and Johnson 1996; House et al. 1990, 1994; Huisman, Kunst, and Mackenbach 2003; Kitagawa and Hauser 1973). For example, House et al. (1990, 1994) found that SES differentials in health inequality are smaller in later old age (75 years and older) than in middle age (35 to 65 years) and early old age (65 to 75 years). Regarding the pattern between SES and mortality, Kitagawa and Hauser (1973) found larger educational differentials in mortality among persons aged 25 to 64 years than among older persons.

We began from the perspective that although many studies have been conducted to test the relationship between SES and mortality among adults, and even among the elderly, past research has not adequately addressed the oldest old population (those aged 80 years and older). Therefore, on the basis of past research, we were left to ponder whether there are significant effects of SES on mortality among the oldest old, particularly those at very old ages (100 years and older). Our study of the oldest old was motivated by previous studies that found smaller SES differentials among the elderly than among adults. If SES differentials become smaller and smaller with age, we might expect them to eventually disappear among the oldest old populations.

In fact, to our knowledge, researchers have not paid adequate attention to the oldest old (say, those aged 80 years and older), especially the extremely old (100 years and older), because of a lack of sufficient data. Most studies to date have not differentiated the oldest old from the younger old. However, this distinction is important, because the younger old and the oldest old are different in several significant respects (Huisman et al. 2003). For example, the younger old are recently retired, and some of them still engage in economic activities, whereas the oldest old usually have been detached from economic activities for more than 15 or 20 years.

In light of current demographic trends of postponed mortality and prolonged longevity, understanding the impact of SES on mortality for the oldest old population (80 years and older) is becoming increasingly important as the total number of individuals in this age group begins to increase. For example, there were 8 million oldest old (80 years and older) in 1990 in China; however, this number will be 114 million in 2050, on the basis of modest mortality assumptions (Zeng and Vaupel 1989). Given this, China is an ideal place to study the oldest old population, especially those aged 90 or more years and 100 or more years. The oldest old population needs the most care, either from families or from society, and a steep increase in their relative population size has significant social policy implications.

In addition, it is important to understand how the relationship between SES and mortality might be different in developing countries than in the developed countries, where most previous studies have been conducted. For example, findings from research in the United States may not be applicable to countries such as China, especially to the oldest old in China, given markedly different socioeconomic and cultural contexts. There are substantial differences between China and developed countries in terms of population structure, societal system, and economic development (Liang et al. 2000). In China, the elderly are not well educated, about 60% of them being illiterate. Although China has begun to develop its social support systems for the elderly, most still rely on family members for financial and material support. Also, although China is transitioning to a market economy, the legacy of the socialist planned economy lingers in some sectors. For historical reasons, the development in rural areas is far behind that of urban areas, further deepening an already sharp divide between the two. These factors make social stratification more complex in China than in developed countries.

In brief, the purpose of our study was to test whether SES differentials in mortality exist among the oldest old Chinese. Our research question was, for the oldest old Chinese, does SES still affect mortality significantly? More specifically, do SES differentials with respect to mortality disappear beyond a particular old age, such as 80, 90, or 100 years?

Methods

Data

A survey of the oldest old Chinese (the Chinese Longitudinal Healthy Longevity Survey [CLHLS]) was conducted in 1998 as a baseline for a longitudinal project on health and longevity.[1] This was a multistage, stratified cluster survey with a response rate of about 88%. The survey, conducted in 631 randomly selected counties and cities of China's 22 provinces, oversampled extremely old persons (i.e., 100 years and older) and oldest old men (Zeng et al. 2001). Nine provinces, such as Xinjiang, Qinghai, and Gansu, where large proportions of ethnic minorities live were not included in this survey, to avoid "potentially inaccurate age-reporting" (Zeng et al. 2001:97). Members of the Han ethnic group, the majority of Chinese, are more likely to accurately remember their birthdates (Wang et al. 1998), largely because of their use of the 12-year-cycle animal zodiac.[2] The respondents were recontacted in follow-up surveys conducted in 2000 and 2002. The baseline (i.e., 1998) survey included 8,959 respondents aged 80 years and older. Of these, 3,355 persons died between the first and second waves, and 1,591 persons died between the second and third waves. Because the survey included detailed demographic and SES variables, we were able to analyze the relationship between SES and mortality among people at the oldest ages.

Age misreporting may be significant among respondents who reported extremely old ages (Wang et al. 1998). The CLHLS incorporated a few strategies to reduce age misreporting. For example, birthdates in both lunar and solar calendars were asked. The interviewers also checked the ages of the respondents' parents, siblings, and children or grandchildren (Gu 2005b).[3] To further protect against potential biases associated with extreme outliers due to age misreporting, we considered only respondents who were younger than 106 years in the base year of 1998. After excluding invalid or incomplete cases, the baseline sample included 7,390 people aged 80 to 105 years, of whom 4,827 people died before the 2002 follow-up survey.

Measures

In this analysis, mortality due to all causes was the dependent variable. Deaths between the baseline survey and the follow-up surveys as well as death dates were recorded by interviewers. The information was obtained from the appropriate proxy respondents, usually the next of kin, and was verified by family members or neighbors. This method has been validated as an appropriate way to collect quality data for mortality research (George 2002), because it yields more updated information than checking household registrations.

The socioeconomic predictor was a composite of education and urbanity at the baseline. In most previous studies, education, income, and occupation have been used as important SES indicators in predicting mortality and health status (Anson and Sun 2004; Bassuk et al. 2002; House et al. 1990, 1994; Lantz et al. 1998; Liang et al. 2002). However, it is not clear that these measures are equally applicable in developing countries, particularly for the oldest old populations. In developing countries, information about older persons' education levels is more easily accessible and constitutes a more valid indicator of SES than income or occupation, because older people may have more than one financial resource, and many of them have retired and may have held multiple jobs in the past (Zimmer et al. 1998). For our study, occupation was a poor measure of SES, although it usually works well for employed populations (Robert and House 2000). This is because more than half of the oldest old in our sample were farmers and had never had other occupations. Therefore, there was not much variation in this variable. In addition, income would not be a good measure, because the oldest old rely on multiple sources of financial and material support, especially from family members. In the data we used for this study, income was unavailable.

We relied on education as a primary measure of SES in our analysis. A large literature on social stratification in the United States has overwhelmingly shown that education is a very strong predictor of a person's SES in adult life (e.g., Blau and Duncan 1967; Hauser and Warren 1997). Buchmann and Hannum's (2001) recent review indicated that education's role in determining SES is no less important in developing countries. For example, education can change an individual's occupational status, labor market participation, and social mobility. Some prior research on SES and health and mortality in China has used education as an SES measure (Anson and Sun 2004; Liang et al. 2000; Zimmer, Martin, and Lin 2005). For example, on the basis of a sample of working-age respondents (16 to 60 years) in rural areas of the Hubei province, Anson and Sun (2004) reported that education significantly predicts health, and this pattern resembles that in Western countries. The study by Liang et al. (2000) showed that education significantly affects old age mortality in Wuhan, China. Two studies on Taiwan by Liu et al. (1998) and Zimmer et al. (2005) also found educational differentials in old age mortality. In this study, education was defined as a dummy variable, noneducated (i.e., schooling years = 0) versus educated (schooling years >0).

Urban versus rural residence presents another important dimension of SES in China. Since the establishment of the household registration system in 1955, the Chinese population has been divided into agricultural (rural) and nonagricultural (urban) sectors. This system limits migration from rural to urban areas and has created large disparities between sectors in strong favor of the urbanites. In fact, as Wu and Treiman (2004) pointed out, status in the household registration system largely determines "access to good jobs, education for one's children, housing, health care, and even the right to move to a city" (p. 363). People who live in rural areas are severely disadvantaged relative to those who live in urban areas in terms of income, health care resources, and so on (Liang et al. 2000). In this study, residence was defined as a dummy variable, with rural coded 0 and urban coded 1.

We created an SES variable with four categories composed of the dual conditions of education and urbanity: (1) noneducated and living in a rural area, (2) noneducated and living in an urban area, (3) educated and living in a rural area, and (4) educated and living in an urban area. Therefore, in the analysis, we divided the oldest old into four socioeconomic groups on the basis of two dimensions of education and urbanity. We discuss in more detail the reasons behind this parameterization of the SES variable in the Appendix. Although our SES measure was composed of two dimensions, education and urban or rural residence, it was still very crude, ignoring heterogeneity in SES within a category of the classification. However, the crudeness of the measure should introduce a conservative bias. If we were indeed to find mortality differentials by our SES measure, it would be likely that such differentials would be more pronounced with a more refined SES measure.

The covariates included age, sex, ethnicity, region, activities of daily living (ADLs), and self-reported health. Age and sex are important determinants of mortality. Age was a continuous time-varying variable, and sex was a dummy variable (with female coded 1). In addition, we included a time-varying variable that represented the lapsed time from the baseline survey of 1998 (time interval). The inclusion of this variable in our analysis did not affect our conclusions, but it pointed out an issue in data quality, discussed below. Ethnicity was categorized as Han (coded 1) or minority (coded 0). Region was a four-category classification: northern, middle, southern, and western.

We also considered ADL and self-reported health at the baseline survey as two important confounding variables. It is difficult to directly gauge the objective health status of old people, especially the oldest old people, in developing countries such as China, because medical diagnoses and records are very poor (Zeng et al. 2000). Thus, ADLs provide a better indicator of the objective health status of the oldest old Chinese than the chronic conditions that often have been used in previous studies. Self-reported health is another health status indicator, a mixed measure of objective health status and subjective feelings about health (Maddox and Douglass 1973). Previous studies have shown that self-reported health is a good predictor of mortality and physical functional decline of the elderly (Benyamini et al. 1999; Idler and Benyamini 1997).

In this study, functional abilities, including eating, dressing, transferring, using the toilet, bathing, and continence, were used to generate a baseline (1998) ADL variable, which was coded 0 for impaired and 1 for not impaired. Self-reported health at the baseline was measured by an interview question that asked respondents to rate their health on a 5-point scale (*very bad*, *bad*, *fair*, *good*, or *very good*). *Very bad* and *bad* were combined and coded 0, and *fair*, *good*, and *very good* were combined and coded 1 in our analysis.

We constructed three alternative age groups to examine whether SES differentials disappeared beyond an old age: the entire group (80 years and older) and two subsets, 90 years and older and 100 years and older. Correspondingly, the first step in our analysis was to examine whether SES differentials in mortality existed among the elderly (80 years and older). We then applied more stringent definitions of elderly age to 90 years and then to 100 years. We repeated the statistical analyses in the more restricted elderly subpopulations to examine if the relationship between SES and mortality disappeared beyond an advanced age at 90 or 100 years.

Table 1 displays the basic information for the study population. Overall, there were more women (60%) than men (40%), and almost half (49%) were rural and noneducated. The distribution of deaths indicates that as age increased, mortality increased. For any given age group, women had lower mortality than men. The oldest old in higher SES strata had lower mortality than people in lower SES strata. For women age 80 or more and 90 or more years, the rural-noneducated and urban-educated gap in percentages of deaths was close to 10%: 43.4% versus 34.5% for those over 80 years and 69% versus 61.3% for those over 90 years. However, the percentages were close (83.5% versus 84.4%) among women over 100 years. Among men of every age group, the percentages of deaths were higher for the rural, noneducated group than for the urban, educated group.

Analysis

We conducted discrete time and proportional hazard analysis involving time-varying covariates to examine the impact of SES on mortality risk. More specifically, we estimated the effects of SES using logit models after we restructured the data into person-periods. The discrete time period used to divide the data is the month.[4] Our analysis involved three steps. First, we estimated the effect of SES on mortality among all respondents (i.e., those aged 80 years and older). Second, we analyzed the effect of SES on mortality

Table 1
Distribution of Socioeconomic Status (SES) and Death Rate by SES

	Number in 1998	Percentage	Deaths, 1998 to 2002	Death (%)
Women				
Age ≥ 80 years				
SES				
Noneducated, rural	2,785	63.9	1,942	43.4
Noneducated, urban	1,179	20.6	778	44.4
Educated, rural	187	7.6	105	30.2
Educated, urban	295	7.9	149	34.5
Age ≥ 90 years				
SES				
Noneducated, rural	2,068	62.4	1,641	69.0
Noneducated, urban	786	27.4	609	65.1
Educated, rural	99	4.5	78	65.4
Educated, urban	133	5.7	94	61.3
Age ≥ 100 years				
SES				
Noneducated, rural	1,171	63.4	979	83.5
Noneducated, urban	355	29.8	303	85.3
Educated, rural	47	2.6	39	82.2
Educated, urban	48	4.2	40	84.4
Men				
Age ≥ 80 years				
SES				
Noneducated, rural	855	29.4	585	51.1
Noneducated, urban	285	5.7	204	58.8
Educated, rural	1,031	43.4	645	44.8
Educated, urban	773	21.5	419	40.2
Age ≥ 90 years				
SES				
Noneducated, rural	504	30.9	402	70.7
Noneducated, urban	169	9.0	138	75.8
Educated, rural	531	37.1	406	65.7
Educated, urban	336	23.0	238	66.2
Age ≥ 100 years				
SES				
Noneducated, rural	153	34.2	141	92.4
Noneducated, urban	55	14.7	49	88.5
Educated, rural	148	33.3	131	88.4
Educated, urban	65	17.8	54	82.8

Note: Numbers are unweighted; percentages are weighted.

among those aged 90 years and older. Third, we focused on those aged 100 years and older. For each step, we created two models, one without and one with health status at the baseline as control variables.

Our analytic strategy had two advantages. First, because we did not know at what old age SES differentials in mortality and health begin to converge, analysis with three alternative target populations (i.e., 80 years and older, 90 years and older, and 100 years and older) sheds new empirical light on how the effect of SES on mortality changes with increasing old age. Second, using health variables as controls in the mortality analysis enabled us to further understand and interpret the relationship between SES and mortality.

Results

We began by estimating the effects of SES without controlling for health status. Table 2 shows the significant effects of SES on mortality for all age groups and SES categories. As shown in column 1, the risk for dying for the educated urban elderly was about 24% less than the risk for the reference group, the uneducated rural elderly (odds ratio = 0.763). The odds of dying for the educated, rural elderly were about 8.2% lower than those for the uneducated rural elderly (odds ratio = 0.918). Additionally, the mortality risk for the urban noneducated did not differ significantly from the reference group, the rural and noneducated, though it was less than 1 (odds ratio = 0.989). In summary, the evidence from Table 2 suggests that SES differentials do not disappear after 80 years of age.

Turning now to the subpopulation aged 90 years and older (Table 2, column 2), the rural educated had slightly lower odds of dying than the rural noneducated (odds ratio = 0.961), though the difference was not significant at the .05 level. The urban educated, however, had a 23.3% lower mortality risk than the rural noneducated (odds ratio = 0.767), and the result was significant at the .001 level. Akin to the population aged 80 years and older, differences between the rural and urban noneducated were neither substantively nor statistically significant (odds ratio = 0.977). Thus, for the population aged 90 years and older, higher SES continued to offer a pronounced protective effect on mortality.

We now consider the extremely old age groups, those aged 100 years and older, an age range only a very small proportion of the world's population today can attain. Column 3 in Table 2 reveals SES effects similar to those found for the population aged 90 years and older. Differences by residence status among the noneducated continued to be small and insignificant (odds

Table 2
Effects of Socioeconomic Status (SES) on Mortality

Variable	Mortality: Age ≥ 80 Years (model 1)	Age ≥ 90 Years (model 2)	Age ≥ 100 Years (model 3)
Sex			
Female	0.794***	0.839***	0.884†
Age (time varying)	1.075***	1.067***	1.050***
Interval	1.007***	1.006***	1.008***
SES			
Noneducated, rural	Omitted	Omitted	Omitted
Noneducated, urban	0.989	0.977	0.991
Educated, rural	0.918*	0.961	1.017
Educated, urban	0.763***	0.767***	0.771**
Model χ^2	1,305.47***	379.09***	62.46***
df	6	6	6

Note: Also included in the models were region and ethnicity. The model χ^2 statistics presented are the differences in model χ^2 between the models presented and the baseline models, in which only region and ethnicity were included as covariates.
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

ratio = 0.991), and the 1.7% higher risk for dying for the rural educated than the rural noneducated (odds ratio = 1.017) was also statistically insignificant. However, the SES premium for the urban educated still existed and decreased only a little, from a 23.3% mortality risk reduction observed for respondents aged 90 and older to a 22.9% risk reduction (odds ratio = 0.771) for those aged 100 years and older.[5]

Table 2 also details the effects of sex and age on mortality. As expected, women exhibited lower mortality than men in every age group. Although mortality increased with age, the rate of increase also dwindled with age. Comparing the magnitude of effects, however, the differentials in mortality across some SES groups were even larger than the sex differential in the subgroups of those aged 90 years and older and 100 years and older.

One point worth noting in Table 2 is that time interval had significant effects, even with time-varying age included in the model. Although we expected that time-varying age would show the effects of the force of mortality over time (mortality increases with age), the observation time during the survey period also affected the likelihood of dying (mortality increases

Table 3
Effects of Socioeconomic Status (SES) on Mortality (controlling for health)

	Mortality		
Variable	Age ≥ 80 Years (model 1)	Age ≥ 90 Years (model 2)	Age ≥ 100 Years (model 3)
Sex			
Female	0.731***	0.770**	0.800**
Age (time varying)	1.062***	1.053***	1.043**
Interval	1.005***	1.009**	1.012***
SES			
Noneducated, rural	Omitted	Omitted	Omitted
Noneducated, urban	0.977	0.957	0.958
Educated, rural	0.960	1.019	1.077
Educated, urban	0.744***	0.743***	0.715**
Self-reported health	0.664***	0.685***	0.713***
Activities of daily living	0.575***	0.584***	0.587***
Model χ^2	1,656.54***	678.79***	227.88***
df	8	8	8

Note: Also included in the models were region and ethnicity. The model χ^2 statistics presented are the differences in model χ^2 between the models presented and the baseline models, in which only region and ethnicity were included as covariates.
*$p < .05$. **$p < .01$. ***$p < .001$.

with observation time independent of age). This finding was unexpected, because it suggests that the mortality risk at every age was higher for those from younger cohorts.

This finding is inconsistent with recent studies that would expect lower mortality risk for younger cohorts. To account for this seeming discrepancy, we considered the role of interview selection. At the first-wave interview, respondents probably needed some adequate level of health that allowed them to be interviewed with or without family members' help. In other words, the elderly who were particularly sick at the beginning of the study would have likely been excluded from the respondent sample.

Consider two groups, group A, which entered the sample at the age of 84 years, and group B, which had aged to 84 by the second wave (i.e., age 82 at baseline). Given the minimal adequate health expectation noted above, the members of group A were on average selectively healthier than the members of group B at the same age of 84, because very sick persons were included in group B but not in group A. Therefore, even though the underlying age patterns of health were the same for the two groups, the health status of observed members of group A was better than that of members of group B. In other words, respondents from both groups should have had sufficiently favorable health status at the first wave to be included in the sample. During the next two years, both groups would have experienced health declines and mortality because of the aging process, and the health of group B individuals as they age to 84 years might have fallen below the baseline levels of group A individuals (who started at 84). Furthermore, because there were no sample selection criteria (i.e., the minimal adequate health expectation) in later waves, members of group B would still be included, even if their health declined to levels below what would have been necessary for sample inclusion in the first wave. Thus, at every age (e.g., 84 years), respondents who have spent more time in the survey have higher mortality than those who have spent less time in the survey, because of this selection process. This process would lead to positive age and interval (observation time) effects simultaneously. In other words, the actual mortality among the older cohorts in our sample was likely underestimated.

Table 3 replicates the models from Table 2, controlling for the health status at baseline. SES continued to have a large and significant influence on mortality. Health status at the baseline did not explain away the relationship between SES and mortality, and in some cases, the results from Table 2 actually became more pronounced. The educated urban elderly continued to have a lower risk for dying than those without education and living in the countryside, regardless of age group. The effects were particularly striking for the extremely old (100 years and older) among the urban educated, for whom we observed a 28.5% reduction in mortality risk (odds ratio = 0.715), which was significant at the .01 level. For other categories of SES, some minor crossovers were found: compared with the rural noneducated, for example, the urban noneducated had a slightly higher risk for mortality (odds ratio = 1.019) throughout the group aged 90 and older, and in the group aged 100 and older, even the rural educated had a slightly higher risk for mortality (odds ratio = 1.077).

Additionally, both health indicators substantially influenced mortality, as shown in Table 3. For those with good self-rated health in the entire group, the odds of dying were 34% lower than for those with poor self-rated health (odds ratio = 0.664). Similarly, people who were ADL unimpaired at the baseline were less likely to die than those who were impaired (odds ratio = 0.575). Furthermore, the mortality reduction associated with self-rated health declined with age, as the odds ratio increased from 0.66 for those aged 80 years and older to 0.71 for those aged 100 and older. However, the effect of ADLs changed little from the group aged 80 and older to that aged 100 and older. These results reveal that ADLs and self-reported health, especially the former, have profound effects on the mortality of China's oldest age groups.[6] Finally, as the results in Table 2 demonstrate, the time interval in Table 3 remained still significant, and its effects increased with age.

In short, Tables 2 and 3 provide three key insights. First, SES has substantial and significant effects on the mortality of China's oldest old. Second, the SES differential is large, comparable in magnitude to the sex differential, particularly for the extremely old (100 years and older). Third, the SES effects we documented are quite robust, whether we changed the target population to the elderly aged 80 and older, 90 and older, or 100 and older. These effects persisted, or even strengthened,[7] after we controlled for health status at the baseline.

Conclusion

This study demonstrates the relationship between SES and mortality among the oldest old Chinese. We show that SES retained significant effects on mortality regardless of whether we operationalized the oldest old as those aged 80 years and older, 90 years and older, or 100 years and older. We found that higher SES reduces the risk for mortality, with the urban educated having a much lower risk for dying than the rural uneducated. This pattern is consistent with the literature on SES and adult mortality.

Most notably, our study found SES-based mortality differentials among the extremely old age group, and we found that the SES premium is even more pronounced after controlling for the baseline health status. The current literature suggests that SES may only have a minimal effect or no effect at all on mortality and health for people at late old ages (House et al. 1990, 1994), although the issues of magnitude and the age of convergence have not been solved (Zimmer et al. 1998). For all three age groups in our study, SES differentials did not disappear either before or after adjustment for baseline health status.

However, our results do not shed new light on whether there is a convergence or divergence trend in China, because the SES differentials may have declined from a higher level or increased from a lower level in an earlier age. We do not have data on persons younger than 80 years of age with which to examine the effects of our SES measure on younger groups. However, our findings present clear evidence that SES differentials in mortality do not disappear altogether among the oldest old Chinese, especially for those aged 100 years and older.

A possible limitation to this study is that the SES measure was limited by the survey data. As discussed in previous literature, multiple indicators representing different dimensions should be used in studies of the SES effects on mortality and health. In this study, the baseline data do not provide SES indicators such as access to medical care, house assets, and luxury products (TV, refrigerator, etc.), which can reflect financial status in developing countries. In addition, because elderly Chinese derive much of their financial support from their children or relatives, their financial situations might depend more on their children's SES than on their own. In a study of the relationship between children's education and parents' physical functioning in Taiwan, Zimmer et al. (2002) demonstrated that both children's and parents' education significantly affect parents' physical functioning. Therefore, examining children's SES and intergenerational transfer should help us further understand their SES. In this study, our SES variable was crude, with a combination of binary measures of education and urban residence, necessarily masking a great amount of heterogeneity within the four groups cross-classified by the two variables. Although the SES measure was not ideal, our conclusion still holds because the crudeness of our SES measure tends to exert a conservative bias, diminishing rather than exaggerating the SES differentials we can observe.

In addition, mortality is likely to have been underestimated in this study. As discussed above, the significant effect of the interval variable indicates that the elderly in poor health are more likely to be selectively excluded from this study than those in good health. Another possibility is that sample attrition in the follow-up survey is partly attributable to respondent deaths.[8] Some respondents who were absent in the follow-up survey may have already died. Gu (2005b) reported that in this data set, there might be 10% to 15% underestimation of mortality for both men and women before age 90 between the 1998 baseline and 2000 surveys. Our results pertaining to the interval variable further confirm the underestimation.

In summary, this study helps clarify the question of whether SES still affects mortality after a certain advanced age. Despite good reasons to expect the relationship to diminish and perhaps disappear altogether after a particular age, our results reveal significant SES-based mortality differentials among very old persons. On the basis of this study, we propose several possible future directions in studying the SES-mortality relationship among the oldest old. First, multiple SES indicators, such as access to medical care, assets, and wealth, should be used in further research. Second, an underlying mechanism between SES and mortality should be addressed. In this study, we focused on whether mortality differentials still persist among the oldest old in China. Given this limited research objective, we included only demographic controls of age and sex but not mediating factors such as social support, marital status, and health behaviors. Now that we have established the existence of SES-mortality differentials among the oldest old, it calls for the inclusion in future studies of mediating factors that may explain the observed SES mortality differentials.

Appendix

To further explain why we used the composite measure of SES based on education and residence, we estimated four additional models for all respondents (i.e., aged 80 years and older), presented in Table A1. In the first model, education was the only SES variable; its coefficient showed that educated elderly had a 16% significantly lower mortality than noneducated elderly. Residence was the only SES variable in the second model, and its coefficient indicated that urban residents were more likely to survive than rural residents. In the third model, we used both education and residence as SES measures. The results indicated that educated and urban residents had a lower risk for dying compared with their counterparts. To further explore the interaction effect of these two measures, we included in the fourth model an interaction term. The significant interaction effect revealed that the effect of education depended on residence and that the fourth model is preferred. Our composite measure with four categories in the analyses is an alternative parameterization of the interaction effect in the fourth model.

Table A1
Effects of Education and Residence on Mortality

Variable	Model 1	Model 2	Model 3	Model 4
Education				
Noneducated	Omitted		Omitted	Omitted
Educated	0.844**		0.856*	0.918*
Residence				
Rural		Omitted	Omitted	Omitted
Urban		0.913**	0.935*	0.989
Education × Residence				0.841*
Sex				
Female	0.786***	0.852***	0.792***	0.794***
Age (time varying)	1.075***	1.076***	1.075***	1.075***
Interval	1.007***	1.006***	1.007***	1.007***
Model χ^2	1,294.94***	1,283.76***	1,299.02***	1,305.47***
df	4	4	5	6

Note: Also included in the models were region and ethnicity. The model χ^2 statistics presented are the differences in model χ^2 between the models presented and the baseline models, in which only region and ethnicity were included as covariates.
*$p < .05$. **$p < .01$. ***$p < .001$.

Notes

1. The sponsoring and supporting institutions for the CLHLS include the National Institute on Aging, the United Nations Fund for Population Activities, the China National Foundation for Social Sciences, Peking University, Duke University, and the Max Planck Institute for Demographic Research (Gu 2005a).

2. The age reporting for the Han oldest old population younger than 106 years of age is almost as good as in developed countries (see Wang et al. 1998; Zeng et al. 2001).

3. Gu (2005b) showed that the age reporting in the CLHLS is valid by examining age heaping, the age progressive ratio, and the density of centenarians.

4. We also estimated Cox models on the basis of exact death dates, and the results were very similar to those from the logit models. We decided to report the logit model results, noting that dates of deaths of the deceased respondents may not have been recalled accurately by proxy reporters.

5. Differences in the coefficients across the three samples, however, were not statistically significant for models reported in Tables 2 and 3.

6. A possible limitation for the ADL measure in this study is that activities used to generate the ADL variable may not be comparable between rural and urban areas. We found that the rural oldest old needed less help in bathing and continence, such that we found that rural persons had better ADL status than urban persons. However, rural people may bathe less frequently than urban people and thus report less difficulty bathing. In addition, a lack of awareness of certain types of caregiving devices and procedures in rural areas may result in responses that elders "do not need help."

7. Surprisingly, we observed a negative relationship between SES and health. We think this might be due to the biases in the measurement of health. Note 5 gives one illustration of the limitation of health measures. "Health and illness are culturally defined, the inclination to report disease and discomfort are culturally embedded" (Anson and Sun 2004:77). Health indicators may differ in their cultural meanings between rural and urban places.

8. According to Gu (2005a), the attrition rates in the data set are normal compared with those in certain developed countries.

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