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SOCIOECONOMIC DISPARITIES IN MORTALITY AMONG CHINESE ELDERLY*

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Abstract

This study examines the association of three different SES indicators (education, economic independence, and household per-capita income) with mortality, using a large, nationally representative longitudinal sample of 12,437 Chinese ages 65 and older. While the results vary by measures used, we find overall strong evidence for a negative association between SES and all-cause mortality. Exploring the association between SES and cause-specific mortality, we find that SES is more strongly related to a reduction of mortality from more preventable causes (i.e., circulatory disease and respiratory disease) than from less preventable causes (i.e., cancer). Moreover, we consider mediating causal factors such as support networks, health-related risk behaviors, and access to health care in contributing to the observed association between SES and mortality. Among these mediating factors, medical care is of greatest importance. This pattern holds true for both all-cause and cause-specific mortality.

Keywords

Mortality Disparity; Aging; China; Socioeconomic Status (SES); Social Inequality

1. INTRODUCTION

Population aging, resulting from declines in fertility and mortality, is a widespread phenomenon now occurring in many countries. This is surely true in China, where the government has maintained a strict national fertility control policy since the 1970s, following its success in reducing mortality after the founding of the People's Republic of China in 1949 (Peng 2011). It is estimated that the number of Chinese ages 65 or older had reached 119 million by 2010 (National Bureau of Statistics of China 2012), and that this figure is expected to grow to 430 million by 2050 (United Nations 2011). The elderly are vulnerable to health problems and thus likely to require emotional, physical, or financial support. Good health among the elderly not only enhances their own quality of life, but also reduces the care burden of their families and society in general. With its large, rapidly

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growing population of elderly people, China represents a crucial, albeit still understudied, context for examining the social determinants of older persons' health.

In this paper, we examine the effect of socioeconomic status (SES) on mortality among the elderly in contemporary China. Indeed, a longstanding literature shows that mortality varies strongly across socioeconomic strata. Observation of an inverse relation between SES and mortality dates back to Villermé (1840) and his study of lifespan variation by occupational class in the French city of Mulhouse during the period 1823 to 1834. The vast literature since then goes further by incorporating a broader range of SES measures and examining the mortality-SES association in a wider variety of social contexts. With few exceptions, the bulk of the literature indicates the existence of a socioeconomic gradient in mortality (for reviews, see Antonovsky 1967; Haan et al. 1989; Feinstein 1993; Adler et al. 1994; Anderson and Armstead 1995; Williams and Collins 1995; Adler and Ostrove 1999; Adler and Rehkopf 2008). This persistent pattern of an association between SES and mortality over time and across places, albeit manifested in different forms in different contexts, suggests that SES is a fundamental cause of mortality (Link and Phelan 1995; Phelan and Link 2005).

Existing studies to date are primarily based on data from the U.S. and other Western countries. One may wonder whether the association of SES with a lower risk of mortality found in previous studies also applies to Chinese elderly, given a number of distinctive social, economic, and political situations in China. First, Chinese elderly are not well educated as a group, with an illiteracy rate of about 50 per cent (National Bureau of Statistics of China 2007). Second, Chinese society is stratified by strong, state-sponsored structural forces, such as *hukou* (the household registration system) (Wu and Treiman 2004, 2007) and *danwei* (work unit) (Walder 1992; Xie and Wu 2008). Finally, although China is currently undergoing a market-oriented transition, its support system for the elderly still relies heavily on the family. During difficult times, including times when the elderly suffer from severe diseases, family members, including extended family members and members of kinship networks, are expected to contribute money and services. To date, there are very few published studies on the association between SES and mortality in China.

In this paper, we use data from the Chinese Longitudinal Healthy Longevity survey to examine whether SES is related to mortality among the elderly in China. In particular, we are interested in how the mechanisms through which socioeconomic factors affect mortality are shaped by the larger sociopolitical context in China. Socioeconomic differentials in mortality are important not only to those who are disadvantaged but also to policymakers who are interested in reducing social inequality and improving population health.

Our paper proceeds in three steps. First, we review the theories and evidence on the relationship between SES and mortality and lay out a conceptual framework that motivates our own research. Second, we examine empirically the role SES plays in determining older persons' mortality. Third, in the concluding section we discuss some of the implications and limitations of our results.

2. THEORY AND EVIDENCE

2.1. Socioeconomic Differences in Mortality

As a fundamental cause, SES shapes a person's exposure to multiple health risks and is linked to a wide variety of resources, such as money, power, prestige, knowledge, and social network, which allow individuals to maintain health and prolong life over time and in different social contexts (Link and Phelan 1995; Phelan et al. 2010). This is manifested in a number of ways. First of all, persons in higher socioeconomic strata receive better health care, especially preventive medical care (Blendon et al. 1989). Higher-SES individuals are not only more able to afford quality care, but also more able to understand and follow instructions of health care providers (Lutfey and Freese 2005). They are always among the first to adopt and reap the benefits of the latest life-saving medical technologies (Link et al. 1998; Chang and Lauderdale 2009; Glied and Lleras-Muney 2009). SES is also positively associated with better material conditions, such as safe water, good sanitation, adequate nutrition and clothing, and well-built housing in safe neighborhoods away from toxic environments (Anderson and Armstead 1995; Evans and Katrowitz 2002; Rosenbaum 2008). Note, however, that with the growing prosperity of lower-SES groups and the continuing decline in the impact of infectious diseases on mortality, these material conditions are losing importance in the SES-mortality link, especially in developed countries.

In addition, research on the mechanisms responsible for the link between SES and mortality highlights the important role played by psychosocial factors (Williams 1990; Mirowsky and Ross 1998). Such factors include perception of mastery and control, stress in family, residential and occupational environments, social integration and support, and health behaviors. Among them, the last two factors have received the most attention in past research. Social support networks (e.g., marriage, relatives, friends, and community ties) can benefit individuals' health and longevity by providing emotional and instrumental support; by encouraging healthy behaviors and discouraging unhealthy behaviors; and by providing health-related information (Smith and Christakis 2008; Rogers et al. 2013). Working through improved conditions of life, higher-SES contributes to the maintenance of social support, stable community ties, organizational involvement (Bishop 1980; Berkman and Glass 2000; Xie et al. 2003), and higher quality social networks. Spouses in higher-SES groups, for example, tend to be more emotionally supportive of each other than those in lower-SES groups, above and beyond a negative association between SES and divorce (Dohrenwend and Dohrenwend 1970). Moreover, the socioeconomically advantaged live healthier lifestyles than the socioeconomically disadvantaged. Specifically, persons in higher social strata are more likely to refrain from smoking, to drink alcohol moderately if at all, to frequently exercise, and to maintain normal weights (Cutler and Lleras-Muney 2010; Lantz et al. 2010; Pampel et al. 2010).

Despite an extensive literature that documents an association between SES and mortality in developed countries (Kitagawa and Hauser 1973; Feldman et al. 1989; Menchik 1993; Bassuk et al. 2002), the literature has so far failed to reveal causal mechanisms through which SES affects cause-specific mortality. A very recent study by Rogers et al. (2013)

represents a notable exception to lack of comparative research on mechanisms and evaluates numerous explanations of the association between education and mortality. Using the National Health and Nutritional Examination Survey Linked Mortality File, they found that the educational gradients in overall adult mortality in the U.S. and in cause-specific mortality were most prominently explained by family incomes and health behaviors, and only weakly explained by social support networks and physiological indicators such as inflammation.

To our knowledge, only three studies have directly examined whether and how socioeconomic factors are associated with mortality among Chinese elderly. In an analysis of people ages 60 and older in Wuhan, China from 1991 to 1994, Liang et al. (2000) found that higher levels of SES (measured by education, household luxury items, and urbanicity) were associated with a lower risk of mortality. More recently, after pooling data from the 1998, 2000, and 2002 waves of the Chinese Longitudinal Healthy Longevity Survey, Zhu and Xie (2007) reported that SES (measured as education and urbanicity) was a significant factor in reducing mortality among Chinese oldest-old. Finally, using data from the 2002 and 2005 waves of the Chinese Longitudinal Healthy Longevity Survey, Wen and Gu (2011) explored the effects of socioeconomic conditions on mortality and found that economic independence was significantly associated with mortality among Chinese aged 65 and older. These three studies also considered whether the SES-mortality association was mediated by a number of variables commonly examined in Western contexts, including stressors (Liang et al. 2000), social relations (Liang et al. 2000; Wen and Gu 2011), and health practices (Wen and Gu 2011). As a whole, these studies have not shed new lights as to how the SES gradient in mortality in China exhibits any peculiar patterns different from those in western societies and unique to China.

Our paper attempts to fill this knowledge gap by examining what is distinctive in the SES-mortality association in contemporary China. Informed by the fundamental cause perspective, we argue that how SES affects mortality in a given social context is a concrete, but conceptually transient, manifestation of an underlying permanent relationship. The specific forms of manifestation are contingent on social, political, and technological contexts. In developed countries, access to health care in the general population is generally adequate, through governmental programs or private insurance markets (Cockerham 2010). As a result, medical care is not the most important determinant of an individual's health; instead, individual-level behaviors play a more important role in the association between SES and mortality (Link and Phelan 1995). This is why previous discussions of the mechanisms for the SES-mortality link in developed countries have rarely paid attention to access to health care. By contrast, in China, health-related behavioral risk factors do not seem to act as an important mediating causal mechanism in the association between SES and health status (Beydoun and Popkin 2005). Given China's recent rapid economic growth, the association between SES and health behaviors is often in the opposite direction from what is commonly observed in developed countries such as the United States: higher SES groups in China are more likely to have unhealthy diets (characterized by higher fat levels and more added sugar), to be obese, to smoke and drink more, and to be sedentary (Du et al. 2004; Kim et al. 2004), although lifestyle changes favoring higher SES groups have gradually taken place in recent years.

Instead of lifestyle differences, one would expect access to medical care to be an important mediator of the SES-health association in China, as persons higher in the social hierarchy can receive much better health care. In the early 1980s, the Chinese government implemented a series of market-oriented reforms in its health care system, including reduction in governmental subsidies for health care, the demise of the Cooperative Medical System along with the dismantling of the agricultural communes, and permission to market expensive new drugs and technologies (Blumenthal and Hsiao 2005; Eggleston 2010). Medical facilities and professionals in China tend to be concentrated in the biggest cities, further contributing to problems in healthcare access and affordability. From 1978 to 2008, per-capita spending on personal health services in China, net of inflation, increased at an annualized growth rate of 7.76% per year, which was higher than the per-capita income growth rate (Blumenthal and Hsiao 2005; Center for Health Statistics and Information 2009; National Bureau of Statistics of China 2010). In the 2008 National Health Service Survey, among respondents who reported being unhealthy in the previous two weeks, about 9% had forgone health care because of its cost; among those who should have been hospitalized in the previous 12 months, 18% had avoided hospitalization due to cost concerns; among those who had been discharged from hospital in the previous 12 months, about 20% had requested a discharge from hospital to reduce expenses; 35% of poor households reported poverty resulting from disease or injury (Center for Health Statistics and Information, 2009).

2.2. Decomposition of Socioeconomic Disparities in Mortality

Studies on the association between SES and mortality rarely compare and evaluate the potential causal mechanisms. To a large extent, the dearth of comparative research on mechanisms reflects the difficulty in decomposing effects that are due purely to each explanatory factor. The previous literature typically accounts for the factors that explain the SES-mortality relationship by comparing the magnitude and significance of the SES coefficient before and after the inclusion of these factors in the regression model (e.g., Rogers et al. 2013). When there are multiple such factors, it is not possible to uniquely attribute their explanatory power, because the explanatory factors are correlated with one another.

While we may not be able to establish the “pure” explanatory power of individual factors, we can place upper and lower bounds on their effects. In other words, we can estimate the maximum amount of the total effect (“upper bound”), as well as the minimum amount (“lower bound”), that can be attributed to each explanatory factor considered. This idea of decomposing is not new (see, e.g., Xie and Shauman 1998), but our paper represents the first attempt to apply this decomposition strategy to explaining socioeconomic differences in mortality.

In summary, the purpose of this article is to gain a more comprehensive understanding of socioeconomic disparities in mortality among Chinese elderly. Towards this objective, we examine both all-cause and cause-specific mortality risks. To our knowledge, this is the first study to investigate SES-mortality association by cause in China. Several studies have suggested that the association between SES and mortality may vary by cause of death. For example, using data from the US National Longitudinal Mortality Study, Phelan et al.

(2004) found that the SES gradient in mortality from highly preventable diseases was much greater than that from less preventable diseases. Moreover, a recent analysis by Rogers et al. (2013) demonstrated that both cardiovascular and respiratory diseases contributed more than cancer to the disparities in overall mortality by educational level among US adults. The mediating influence of medical care, material conditions, health behaviors, and social relations may also vary by cause of death (Rogers et al. 2013). We evaluate whether or not these findings hold true in contemporary China.

3. DATA, MEASURES, AND METHOD

3.1. Data

Data used in this paper came from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), conducted by the Peking University Center for Healthy Aging and Family Studies and the China Mainland Information Group. The CLHLS is a longitudinal survey with five waves, i.e., the 1998 baseline and the 2000, 2002, 2005, and 2008 follow-up surveys. The sample consisted of elderly respondents drawn with a multistage, stratified sampling method from 22 of China's 31 provinces. For the first two waves of the study, the CLHLS focused on the oldest-old, ages 80 and older. From 2002 on, young elders, ages 65 to 79, were also included in the sample. (A detailed description of the data and quality control procedures can be found at http://centerforaging.duke.edu/chinese-longitudinal-healthy-longevity-survey.)

For our study, we restricted analysis of the data to a sample of elderly persons ages 65 to 105 in the 2005 wave as our baseline. We made this restriction primarily because the exact question on cause of death did not remain the same in all follow-up surveys. For those who died between the first and second waves, between the second and third waves, or between the third and fourth waves, the CLHLS only collected information on their main cause of death; for those who died between the fourth and fifth waves, it collected information on their specific causes of death. Of the 15,355 respondents in the 2005 wave, 7,410 (48.3 per cent) were reinterviewed in the 2008 wave; 5,027 (32.7 per cent) died before the 2008 follow-up; and 2,918 (19.0 per cent) were lost to follow-up.

The CLHLS is an ideal dataset for this study. Its main advantage lies in the availability of rich information on both SES and death. SES measures include education, economic independence, and household per-capita income. For death, the CLHLS contains underlying cause of death and date of death. The reliability of the data for death causes is a key issue in China, where not all deaths occur in hospitals or health establishments. We have reason to think that major causes of death in our dataset are reasonably reliable, because about 80 per cent of the deceased in this sample received medical treatments prior to death. Death information was gathered through death certificates or the next of kin if death certificates were unavailable. The longitudinal nature of the CLHLS also makes it possible to evaluate the influence of potential causal pathways between SES and mortality.

3.2. Measures

In this analysis, we examined mortality risk from 2005 to 2008. Apart from overall mortality, we analyzed four major underlying causes of death, categorized using the tenth

revision of the International Classification of Disease (World Health Organization 2010). These categories included the following: circulatory diseases (i.e., heart disease, hypertension, and cerebrovascular disease), respiratory diseases (i.e., bronchitis, pneumonia, chronic obstructive pulmonary disease, and asthma), cancer at all locations, and diabetes. These are four leading causes of death among the elderly in the United States (Heron 2012) and are also increasingly important in China (Yang et al. 2008). Data limitations do not allow for the separation of types of cancer. While we recognize that not all cancers are equally preventable and that this measure is therefore crude, for the purposes of this study, the important distinction is that cancer is relatively less preventable than circulatory disease, respiratory disease, and diabetes.

Conventional measures of SES are education, income, and occupation, which have already been shown to be important factors for mortality and health status in developed countries (House et al. 1990, 1994; Alder et al. 1994; Anderson and Armstead 1995; Williams and Collins 1995; Huisman et al. 2003). However, it is quite possible that these measures may not play as important a role in developing countries, especially for the elderly in China. Education is an important SES indicator in China but does not vary much for a significant portion of rural elderly Chinese, who are mostly illiterate. Income may be a poor measure of SES in this context, because most Chinese elderly have withdrawn from the labor market and rely heavily on their children for financial support. That is, personal income is unlikely to capture financial resources available to the elderly. Occupation may also be a poor measure of SES for our study, partly because most elderly persons held the same occupation, being peasants (Zhu and Xie 2007), and partly because the CLHLS only measured occupation very crudely, with only 8 pre-fixed occupational categories for respondents to choose from. In the CLHLS, these 8 occupational categories include (1) professional or technical personnel; (2) governmental, institutional or managerial personnel; (3) agriculture, forestry, animal husbandry; (4) fishery worker; industrial worker; (5) commercial or service worker; (6) military personnel; (7) housework; and (8) others. Instead of exclusively relying on these conventional indicators of SES, we used one traditional indicator, education, combined with two alternative indicators, economic independence and household per-capita income.

In the pre-communist era and the early years after the transition to communism in China, education was out-of-reach for most ordinary people. As a result, today's elderly are not well-educated as a group. For this reason, we classified individuals as belonging to one of two groups: no education and some education. In earlier studies of the SES-health relationship based on U.S. or European data, education has been widely used as an indicator of SES, and the overwhelming majority of these studies find education to be a strong predictor of health and mortality. Some studies have also used education as an indicator of SES to predict health outcome in China (Liang et al. 2000, 2001; Zimmer and Kwong 2004; Beydoun and Popkin 2005; Zhu and Xie 2007). For example, using data collected in 1991 and 1994 in Wuhan, Liang et al. (2000, 2001) found that education significantly reduced old age mortality and functional status decline.

We defined economic independence as a dichotomous variable, which was coded 1 if the respondent's daily expenses could be paid by his retirement wage/pension or other income,

and 0 if it could not be paid. One study by Wen and Gu (2011) suggested that being economically independent was associated with lower rates of mortality among the elderly in China.

In the 2005 wave of the CLHLS, *household per-capita income* was directly assessed by the following question: "What was the income per capita of your household last year?" About 0.21 per cent of the respondents were top-coded as "more than 100,000 yuan." We followed standard practice (e.g., Mouw and Kalleberg 2010) and replaced top-coded income with 1.4 times the top-coded value. To adjust skewness in per-capita income, we transformed it by the logarithm function.

In this study, we also considered some of the potential mechanisms that link SES to mortality. Three groups of variables – (a) social relations, (b) health behaviors, and (c) access to and use of health care – have commonly been postulated to mediate between SES and mortality. Regarding social relations, we had information on current marital status (married vs. non-married), number of living children, and proximity to children. Elders who had children living in the same household or in the same village/on the same street were coded as having high proximity to children; otherwise, the elders were coded as having low proximity. Regarding health-related behaviors, we had information on whether or not an individual ever smoked, ever drank alcohol heavily (defined as drinking 100 grams of liquor, 200 grams of wine, or 400 grams of beer/rice wine per day), and ever exercised regularly, respectively. Regarding access to health care, the survey asked whether or not the elderly respondents could get adequate medical care if they should fall seriously ill.

The covariates in our multivariate analysis included age, sex, ethnicity, current residence, and region. Age and sex have been well documented as relating to mortality and health. Age was a continuous variable. Sex was a dummy variable (0=male; 1= female). Ethnicity was converted into a binary variable (1=*Han* ethnic Chinese; 0=minorities). Current residence was also a dummy variable (0=rural; 1= urban). To capture regional variations in socioeconomic development, we grouped the 22 provinces sampled into three regions: East, Middle, and West. Great disparities existed in the level of socioeconomic development across the three broad geographical regions.

3.3. Analytical Strategy

To explore how and why SES affects mortality risk, we regressed date of death on the predictor variables using Cox proportional hazards models. For analysis of all-cause mortality, those who survived from the 2008 wave were right-censored. For analysis of mortality by cause, death from a specific cause was compared with survivors, with data on persons who died from other causes during the follow-up interval censored at the time of their death.

To reduce the influence of missing values on the modeling outcomes, we used a multiple imputation approach based on 10 random multiple-imputed replicates to fill in missing values (Allison 2002). The proportions of missing values of the variables that were subject to multiple imputations in this study were the following: years of schooling, 0.36 per cent; economic independence, 0.02 per cent; household per-capita income, 8.72 per cent; smoke,

0.01 per cent; and drink, 0.02 per cent. Those who were lost to follow up were excluded from our analysis, based on preliminary results that were comparable when we included the censored observations using multiple imputation.

4. RESULTS

4.1. Descriptive Results

Table 1 provides descriptive statistics for all variables for the entire sample (column 1) and for the deaths occurring during the follow-up period (column 2). For categorical variables, percentage distributions are shown; for continuous variables; mean values are shown. Highly consistent with the 2005 mini census (National Bureau of Statistics of China 2007), only about 52.5 per cent of the respondents had attended school. Most of the respondents were economically independent (about 74.5 per cent), with a sample mean family income per capita of 2,445 yuan.

A comparison of the two columns for SES variables shows that death was more likely to occur among those who were less educated, were economically dependent, and had lower family per-capita incomes. Those who were currently married, had a larger number of living children, and had access to medical care were less likely to die. Moreover, those who were ever smokers, were ever heavy alcohol drinkers, and never took exercise regularly exhibited higher percentages of death relative to the same categories for the entire population. However, these are simply bivariate tabulations, which are strongly influenced by age structure. To model all-cause mortality risk while taking age and other covariates into account, we turn to Table 2.

4.2. Multivariate Results

Table 2 presents a multivariate model of the association between SES and all-cause mortality risk. Model 1 displays the SES and mortality relationship, controlling for age, sex, ethnicity, residence and region. Consistent with the basic descriptive results shown in Table 1, the socioeconomically advantaged elderly exhibited lower mortality risks over the follow-up period. Compared with the noneducated, the educated exhibited 3.2 per cent lower risks of dying, though the difference was not significant at the 0.05 level. However, we found a strong protective effect of economic independence: elders with economic independence had −7.2 per cent lower risks of dying during the follow-up period than those without. The estimated coefficient of logged household per-capita income was also statistically significant and negative, meaning that higher family per-capita income reduced mortality risk. Specifically, the risk of dying decreased 0.03 percentage point for a one-percent increase in family per-capita income.

In the remainder of Table 2, we consider the role of intervening mechanisms in explaining the effect of SES variables on mortality among the elderly in China. We test social relations, health behaviors, and access to medical care, that are commonly hypothesized to mediate the effects of SES. Models 2 through 4 add these three sets of possible mediating variables in sequence. Model 5 includes the full set of independent variables.

Of the three social relation items added in Model 2, only the effect of marital status achieved statistical significance. Compared with the currently unmarried elderly, the currently married exhibited 14.5 per cent lower risks of dying. The association between SES and mortality, however, was quite similar to that reported in Model 1, suggesting that social relations failed to account for the SES-mortality link. Because the elderly in the higher SES group were more likely to abstain from smoking, drink moderately, and exercise regularly, controlling for health behaviors attenuated the association between economic independence and mortality, though the coefficients for the effect of education and family per-capita income hardly changed (compare Model 3 with Model 1). Thus, differing from some other studies (e.g., Wen and Gu 2011), we find some supportive evidence that SES works, in part, through improving and maintaining good health behaviors so as to lower the risks of mortality. For those able to access adequate medical care when seriously ill, the risk of dying was 10.3 per cent lower than that for those with no access. After we included access to medical care, the coefficient for the effect of economic independence was reduced by 37.3 per cent and became insignificant from zero even at the 0.1 level, though the coefficients for education and family per-capita income changed slightly (compare Model 4 with Model 1). The attenuated effects for those with higher SES suggest that access to medical care played a part in the lower risk of mortality for this group. Finally, once we control for all mediating variables there are no statistically significant socioeconomic differences in all-cause mortality (Model 5).

Table 3 presents the results of cause-specific models of SES and mortality, controlling for the different sets of independent variables as in the all-cause mortality models. Although the elderly in the higher SES group enjoyed lower rates of overall mortality, the pattern varies by cause of death (Model 1 for each cause of death). Like previous researchers (e.g., Phelan et al. 2004; Rogers et al. 2013), we find that SES was more strongly inversely related to mortality from more preventable causes (i.e., circulatory disease and respiratory disease) than that from less preventable causes (i.e., cancer). Specifically, for both circulatory and respiratory diseases, mortality was higher among the elderly in lower SES groups than among those in the higher SES group. For example, Chinese elderly who were economically independent had about 18.5 per cent lower risks of circulatory disease mortality and 23.2 per cent lower risks of respiratory disease mortality, respectively, within the three-year follow-up interval compared with those who were economically dependent. For cancer, the mortality risk did not differ significantly between elderly in high-SES and those in low-SES groups. Contrary to expectation, in China, diabetes seemed to be a disease of the rich, with persons of higher SES at higher risk of dying from diabetes. Compared to a lack of schooling, having schooling significantly increased the risk of diabetes mortality by 65.4 per cent. The elderly from higher-income families also had higher risks of diabetes mortality than those from lower-income families. A possible explanation for this negative finding is that the risk factors for diabetes, such as obesity, initially occurred with greater frequency in individuals of higher SES, and thus a positive association between SES and diabetes appeared in China at this time. The SES gradient for diabetes mortality may well reverse in the future.

In Models 2 through 5 of Table 3, we demonstrate for each cause of death the impact of the mediating factors on the association between SES and cause-specific mortality. For each

cause-of-death category analyzed, the inclusion of social-relation variables in Model 2 had relatively little influence on socioeconomic mortality differences. The inclusion of behavioral factors, on the other hand, had an attenuating influence on the socioeconomic differences in circulatory-disease, respiratory-disease, and diabetes mortality, particularly when we compared those who were economically independent with those who were not (comparing Model 3 with Model 1). For example, the 23.2 percent lower respiratory disease mortality for those who were economically independent was reduced slightly to a 22.4 percent difference, with the inclusion of health behaviors. The mediating effects of health behaviors were highly possible, because cigarette smoking is related to SES and to circulatory-disease,- respiratory-disease, and diabetes mortality. When we examined circulatory disease and respiratory disease mortality, access to medical care was a highly important mediating variable. Comparing Model 4 with Model 1 demonstrated that the inclusion of access to medical care evinced a substantially reduced association between SES and circulatory (respiratory) disease mortality. For diabetes mortality, the medical-care pathway also constituted a negative contribution to the relationship between SES and diabetes mortality, but it was more than outweighed by positive contributions from other mechanisms.

4.3. Decomposition of Explanatory Power

Next we formally conduct analysis to determine the unique contribution of social relations, health behaviors, and access to medical care in explaining the mortality gap across socioeconomic groups. The method is described in Xie and Shauman (1998). To implement this method, we estimate Cox proportional hazard models predicting mortality risk under two starkly different situations and use changes in the coefficients of SES variables to measure the explanatory power of the individual factors. When an SES variable has a protective effect, it should have a negative estimated coefficient in the Cox model, labeled as β_{ses}. Estimating the lower bounds of their effects is based on the decrease in β_{ses} (i.e., becoming more negative) after an explanatory factor (the *k*th variable) is taken out of the full model (Model 5 for all-cause mortality in Table 2 or for cause-specific mortality in Table 3). Expressed formally, the lower bound is obtained by the following equation (omitting the subscript for SES):

$$L = \exp(\beta^5) - \exp(\beta^{5-k}),$$

where β^5 denotes the SES coefficients for Model 5, and β^{5-k} denotes the SES coefficients for the model in which the *k*th factor is excluded from Model 5. The rationale for this equation capturing the lower bound of explanatory effects is the following. If the *k*th factor is correlated with the other covariates also included in Model 5, then part of explanatory power is already captured by the other covariates. As a result, *L* merely captures the additional explanatory effects of the *k*th factor that are uncorrelated with all other factors.

Estimating the upper bounds of the effects is based on the increase in β_{ses} from the baseline model (Model 1 for all-cause mortality in Table 2 or for cause-specific mortality in Table 3) after an explanatory factor (the *k*th variable) is added to the baseline model (again omitting the subscript for SES):

$$U = \exp(\beta^{1+k}) - \exp(\beta^{1}).$$

U offers an upper bound estimate for the *k*th factor because part of its explanatory power can also be captured by the other covariates of interest that are correlated with it. Therefore, *U* measures the maximum explanatory effects that can be attributed to the *k*th factor.

Table 4 presents the results from the decomposition analysis for all-cause mortality. In this table, we report the proportion of the socioeconomic gap in mortality that is explained separately and simultaneously by social relations, health behaviors, and access to medical care. Two findings stand out. First, the joint explanatory power, [exp(β^5) − exp(β^1)] was very small for family-income gradient in mortality, but moderate for mortality gradients by education or economic-independence status. Second, the relative importance of these three sets of factors in explaining the mortality gradient varies by SES measure. Health behaviors explained a moderate part in the educational gap in mortality. Access to medical care accounted for a larger proportion of the economic-independence related gap in mortality. Since the effect of education on all-cause mortality was not statistically significant net of economic independence and family income (Table 2), we can conclude that access to medical care played a more important role in explaining the association between SES and mortality, relative to social relations and health behaviors.

In Table 5, we show the results from the decomposition analysis for each cause of death. Here, the joint explanatory power of social relations, health behaviors, and access to medical care was generally higher for the economic independence gap than for the education (family income) gap. Of the three SES measures used here, only economic independence was a significant predictor of circulatory disease and respiratory disease mortality (Table 3), so we focus on the explanatory power of social relations, health behaviors, and access to medical care in economic-independence related mortality. As in the case of all-cause mortality, access to medical care was of greater importance in explaining the association between economic independence and circulatory disease mortality and the association between economic independence and respiratory disease mortality.

5. CONCLUSION AND DISCUSSION

Using data from the most recent waves (up to 2008) of the Chinese Longitudinal Healthy Longevity survey, this study examines the association of three different SES indicators (education, economic independence, and household per-capita income) with mortality among the Chinese elderly. It extends the previous studies (Liang et al. 2000; Zhu and Xie 2007; Wen and Gu 2011) in several important ways: (1) it uses a more recent dataset, with a large, nationally representative sample of Chinese elderly in a wider age range (65 and older); (2) it explores the possibility that the association between SES and mortality varies by cause of death in a non-Western context; and (3) it examines potential causal mechanisms through which SES affects mortality with a decomposition analysis.

One of our central findings is the existence of socioeconomic differentials in mortality among the Chinese elderly. Although China is often characterized by its distinctive social,

cultural, and political systems (e.g., Confucian ideology and work unit), China is not immune from exhibiting a commonly observed positive association pattern between SES (at both the person level and the family level) and mortality. Variations in the strength of the associations between different SES measures and mortality are observed, with weaker association found with education than with economic independence and family per-capita income. No matter whether economic dependence and family per-capita income were controlled or not, education was not significantly related to all-cause mortality among Chinese elderly. This result counters conventional wisdoms that education is fundamentally predictive of mortality (Elo and Preston 1996; Rogers et al. 2013). We speculate that education is not a good measure of SES among Chinese elderly. In the early twentieth century, only a small proportion of Chinese people received formal education, and those without formal education could still be socially and economically successful through agriculture, skilled blue-collar work, or other means. Nevertheless, we find that economic independence and family per-capita income were significant predictors of later-life mortality in China. Accordingly, social policies to reduce poverty may help to improve population health and close socioeconomic disparities in mortality.

Another important finding from this study is that the association between SES and mortality varies by cause of death. Among Chinese elderly, SES was more strongly inversely related to mortality from more preventable causes (i.e., circulatory disease and respiratory disease), than from less preventable causes (i.e., cancer). According to Phelan et al. (2004), this pattern constitutes supportive evidence for SES as a fundamental cause of health and longevity. This finding is consistent with recent evidence from studies of adults in Western societies (Phelan et al. 2004; Rogers et al. 2013).

In addition to exploring the total health effects of SES conditions, we also evaluate whether these associations are mediated by three potential causal mechanisms: support networks, health behaviors, and access to medical care. In line with previous research in China (Wen and Gu 2011), social support failed to account for the association between SES and mortality among the elderly. Health behaviors, on the other hand, explained some portion of the association between SES and mortality. Reducing the unhealthy lifestyles among the socioeconomically disadvantaged could reduce social disparities in mortality. More importantly, our decomposition analyses indicate that access to medical care is of greater importance in accounting for the link between SES and mortality, compared to support networks and health behaviors. Our findings are in sharp contrast with those based on data derived from developed countries, because most studies have reported stronger mediating influence of health behaviors (e.g., Rogers et al. 2013). Our cause-specific analyses further demonstrate that the elderly in higher socioeconomic strata reduced their risk of death mainly by getting access to medical care. Both circulatory and respiratory disease mortality displayed a sizable socioeconomic gap that was influenced by access to medical care. Because circulatory and respiratory diseases are the leading causes of death among Chinese elderly (He et al. 2005), reducing them would probably have an exceptionally large impact on the overall social disparities in mortality.

Our findings suggest that promoting medical-care access might be a direct way to increase life expectancy and reduce social inequalities in mortality. Since the early 2000s, in China

aggressive state health insurance programs have been established to expand coverage in both rural and urban areas (Li et al. 2011). In rural areas, the government introduced the New Rural

Cooperative Medical Scheme; in urban areas, effort has been made to increase the coverage of the Urban Resident Basic Medical Insurance Scheme. These two medical schemes constitute an important move, which can improve the affordability of medical care and thus the accessibility of healthcare services (Wagstaff et al. 2009). It is also necessary to develop affordable community-based services to provide healthcare access to elders. We believe that the life expectancy of Chinese elderly will increase and social disparities in health will decrease if access to health care is improved.

Although we believe that our findings provide new insights into the association between SES and mortality among the elderly, especially in China, we need to acknowledge several limitations of our study. First, in the current analysis, individuals lost to follow-up surveys were dropped from our analysis. Those remaining in the sample may be healthier than those lost to follow-up. Second, measures of SES and mortality causes were based on proxy reports, which may suffer from reporting errors. Third, due to limitations in the CLHLS, measures of political factors that are known to be important in reform-era China, such as work unit and political status, were not available. Earlier research has shown that despite the economic reform that has shifted the stratification locus from the government towards the market, political factors still play a large role in determining such outcomes as income, housing, health care, and pension (Bian and Logan 1996; Xie and Hannum 1996; Zhou 2000; Xie and Wu 2008). It is possible that they are important in affecting health outcomes. We welcome future research examining the influences of those structural dimensions of socioeconomic status that are unique in the Chinese context on mortality.

To conclude, our results show that SES is also strongly associated with mortality risk among Chinese elderly. Our results also show that the extent to and the mechanisms through which socioeconomic factors affect mortality are shaped by the larger sociopolitical context in China. The influence of education on mortality is not as salient or robust among Chinese elderly as that previously shown among their Western counterparts. Moreover, unlike in developed countries where health behaviors explain the SES-mortality relationship substantially, access to medical care is a very important mediator of the SES-health association in China. Accordingly, those doing research on the association of SES with mortality and with health conditions in general, well as those planning social policies to improve population health and reduce health inequality should pay attention to the larger sociopolitical context in which SES exerts its effects.

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Table 1

Descriptive statistics for variables in the analysis, CLHLS 2005–2008

	Total	Deaths
Socioeconomic conditions		
Received 1+ years of schooling (%)	52.53	46.74
Economic independence (%)	74.46	69.60
Logged household per-capita income	7.80	7.72
Social relation variables		
Currently married (%)	61.82	53.13
High proximity with children (%)	76.52	77.68
Average number of living children	3.84	3.80
Health-related behaviors		
Ever smoke (%)	42.60	46.75
Ever drink alcohol heavily (%)	22.08	24.07
Ever exercise regularly (%)	47.72	44.83
Access to health care (%)	90.04	86.68
Sociodemographic variables		
Female (%)	51.35	49.74
Mean age	72.54	76.17
Ethnic minorities (%)	6.43	6.53
Urban (%)	39.10	39.13
Region		
East (%)	41.94	37.59
Middle (%)	26.29	30.41
West (%)	31.77	32.00
N	12,437	5,027

Notes: Numbers are unweighted; percentages and means are weighted.

Source: Chinese Longitudinal Healthy Longevity Survey (2005 and 2008)

Table 2

Cox proportional hazards regression coefficients predicting overall mortality

	Model 1	Model 2	Model 3	Model 4	Model 5
Literacy	−0.033	−0.029	−0.011	−0.032	−0.007
Economic independence	−0.075*	−0.076*	−0.063+	−0.047	−0.042
Income	−0.025*	−0.025*	−0.022+	−0.023*	−0.020
Social relations		Yes			Yes
Health behaviors			Yes		Yes
Access to medical care				Yes	Yes
N	12,437	12,437	12,437	12,437	12,437

Notes: Also included in the models as covariates were age, sex, ethnicity, and region. Indicators of social relations consist of current marital status, proximity to children, and number of living children; indicators of health behaviors consist of ever smoking, ever drinking alcohol heavily, and ever exercising regularly.

*** <0.001;

** p<0.01;

* p<0.05;

+ p<0.1.

Source: As for Table 1

Table 3

Cox proportional hazards regression coefficients predicting cause-specific mortality

	Model 1	Model 2	Model 3	Model 4	Model 5
Circulatory Disease (Deaths N= 1,420)					
Literacy	0.102	0.105	0.109+	0.103	0.113+
Economic independence	−0.204***	−0.212***	−0.199***	−0.158*	−0.164*
Income	−0.013	−0.013	−0.012	−0.009	−0.007
Respiratory disease (Deaths N= 580)					
Literacy	0.105	0.105	0.124	0.108	0.125
Economic independence	−0.264**	−0.263**	−0.253**	−0.174+	−0.168+
Income	−0.050	−0.048	−0.047	−0.042	−0.037
Cancer (Deaths N= 225)					
Literacy	−0.067	−0.086	−0.029	−0.063	−0.049
Economic independence	−0.136	−0.139	−0.128	−0.002	−0.001
Income	−0.040	−0.042	−0.035	−0.030	−0.026
Diabetes (Deaths N= 145)					
Literacy	0.503*	0.488*	0.517*	0.511*	0.510*
Economic independence	−0.096	−0.104	−0.087	0.042	0.042
Income	0.150+	0.146+	0.154+	0.170*	0.169+
Social relations		Yes			Yes
Health behaviors			Yes		Yes
Access to medical care				Yes	Yes

Notes: Also included in the models as covariates were age, sex, ethnicity, and region. Indicators of social relations consist of current marital status, proximity to children, and number of living children; indicators of health behaviors consist of ever smoking, ever drinking alcohol heavily, and ever exercising regularly.

*** <0.001;

** p<0.01;

* p<0.05;

+ p<0.1. N= 12,437

Source: As for Table 1

Table 4

Decomposition of socioeconomic disparities in overall mortality (in Percentages)

	Literacy		Economic independence		Income	
Explanatory Factor	**"low"**	**"High"**	**"low"**	**"High"**	**"low"**	**"High"**
Social relations	0.3	0.3	−0.3	−0.1	0.0	0.0
Health behaviors	2.1	2.2	0.7	1.1	0.3	0.3
Access to medical care	0.0	0.1	2.1	2.6	0.2	0.2
All factors: $\exp(\beta^5)$-$\exp(\beta^1)$	2.5		3.0		0.5	

Notes: The entries represent the amount of socioeconomic disparities in overall mortality that is explained by each category of factors. Two methods are used. The first method, labeled "low," is based on the decrease in the coefficient of the SES variable after one category of explanatory factors are taken out of the full model (Model 5 of Table 2). The second method, labeled "high," is based on the increase in the coefficient of the SES variable after one category of explanatory factors are added to the baseline model (Model 1 of Table 2). In general, the "low" method tends to be too conservative, whereas the "high" method tends to be too liberal. The last row, defined as the difference in the coefficient for the SES variable between the full model and the baseline model, gives the upper limit of the explanatory power. All calculations ignore sampling error.

Table 5

Decomposition of socioeconomic disparities in cause-specific mortality (in Percentages)

	Literacy		Economic independence		Income	
Explanatory Factor	**"Low"**	**"High"**	**"Low"**	**"High"**	**"Low"**	**"High"**
Panel 1: Circulatory Disease						
Social relations	0.4	0.3	−0.9	−0.6	0.0	0.0
Health behaviors	0.8	0.8	0.3	0.4	0.1	0.1
Access to medical care	0.0	0.2	3.6	3.8	0.4	0.4
All factors: $\exp(\beta^5)$-$\exp(\beta^1)$	1.3		3.3		0.6	
Panel 2: Respiratory disease						
Social relations	0.1	0.1	−0.3	0.1	0.1	0.2
Health behaviors	1.9	2.2	0.7	0.9	0.3	0.3
Access to medical care	0.1	0.4	6.8	7.2	0.7	0.8
All factors: $\exp(\beta^5)$-$\exp(\beta^1)$	2.4		7.7		1.2	
Panel 3: Cancer						
Social relations	−1.7	−1.8	−0.1	−0.3	−0.1	−0.2
Health behaviors	3.1	3.6	0.2	0.7	0.6	0.5
Access to medical care	−0.1	0.3	12.1	12.5	1.0	1.0
All factors: $\exp(\beta^5)$-$\exp(\beta^1)$	1.6		12.6		1.4	
Panel 4: Diabetes						
Social relations	−1.9	−2.4	−0.7	−0.7	−0.4	−0.5
Health behaviors	2.1	2.3	0.9	0.9	0.4	0.4
Access to medical care	1.0	1.4	13.2	13.4	2.2	2.3
All factors: $\exp(\beta^5)$-$\exp(\beta^1)$	1.3		13.5		2.2	

Notes: The entries represent the amount of socioeconomic disparities in cause-specific mortality that is explained by each category of factors. Two methods are used. The first method, labeled "low," is based on the decrease in the coefficient of the SES variable after one category of explanatory factors are taken out of the full model (Model 5 of Table 3). The second method, labeled "high," is based on the increase in the coefficient of the SES variable after one category of explanatory factors are added to the baseline model (Model 1 of Table 3). In general, the "low" method tends to be too conservative, whereas the "high" method tends to be too liberal. The last row in each panel, defined as the difference in the coefficient for the SES variable between the full model and the baseline model, gives the upper limit of the explanatory power. All calculations ignore sampling error.