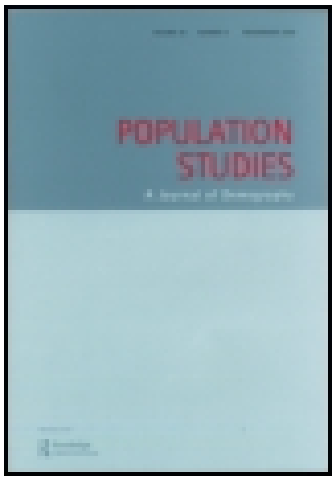

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Socio-economic disparities in mortality among the elderly in China

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Socio-economic disparities in mortality among the elderly in China

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This longitudinal study of mortality among the elderly (65 and over) in China used a large representative sample to examine the association between mortality and three different socio-economic status (SES) indicators—education, economic independence, and household income per head. The results, while varying depending on the measures used, show that there is strong evidence of a negative association between SES and overall mortality. A cause-specific analysis shows that SES is more strongly related to the reduction of mortality from more preventable causes, such as circulatory disease and respiratory disease, than from less preventable causes such as cancer. We also investigated the effects of three sets of factors that may mediate the observed SES–mortality relationship: support networks, health-related behaviours, and access to health care. The results show that for both overall and cause-specific mortality, access to health care is the most important of the three.

Keywords: mortality disparity; ageing; China; socio-economic status (SES); social inequality

[Submitted March 2012; Final version accepted January 2014]

1. Introduction

As a result of declines in both fertility and mortality, populations are ageing in many countries. The phenomenon is especially marked in China, where the government has maintained a policy of strict control over fertility 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 in 2010 the number of Chinese aged 65 or over had reached 119 million (National Bureau of Statistics of China 2012), a figure expected to grow to 430 million by 2050 (United Nations, Department of Economic and Social Affairs, Population Division 2011). This is a huge number for a section of the population that is particularly vulnerable to health problems, and more likely to require emotional, physical, or financial support than other sections. Since good health among the elderly not only enhances their own quality of life, but also means they are less likely to burden their families or society in general, it is important to improve our understanding of the social factors that affect their health. This was the purpose of the study reported here, which examined the effect of socio-economic status (SES) on mortality among the elderly in contemporary China.

There is a long-standing literature showing that mortality varies strongly across socio-economic strata. In 1840, Villermé was the first to observe an inverse relationship between SES and mortality in his study of lifespan variation by occupational class in the French city of Mulhouse in the period 1823–34. Since then a huge number of studies have been reported, incorporating a broader range of SES measures and examining the mortality–SES association in a wider variety of social settings. The bulk of this literature reports the existence of a socio-economic 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). The persistent association between SES and mortality over time and across space, albeit manifested in different forms in different places, indicates that SES is a 'fundamental cause' of mortality (Link and Phelan 1995; Phelan and Link 2005).

Existing studies have been based primarily on data from the USA and other Western countries. It is not realistic to assume that findings elsewhere

apply also to the elderly in China, given the country's distinctive social, economic, and political characteristics, for three reasons. Firstly, the elderly in China are not well educated; they have an illiteracy rate of about 50 per cent (National Bureau of Statistics of China 2007). Secondly, Chinese society is generally stratified by strong, state-sponsored, structural forces, such as the household registration system (*hukou*) (Wu and Treiman 2004, 2007) and the organization of the population into 'work units' (*danwei*) (Walder 1992; Xie and Wu 2008). Thirdly, although China is currently undergoing a transition towards a more market-oriented economic system, the elderly members of Chinese society still rely heavily on their families for support. If an elderly person experiences periods of difficulty, such as severe ill health, his or her family members, including members of the extended family and wider kinship network, are expected to help by contributing both money and services.

Our research used data from the 2005 and 2008 waves of the Chinese Longitudinal Healthy Longevity Survey to examine the ways in which SES is related to mortality among the elderly in China. In particular, we wished to examine the mechanisms through which socio-economic factors affect mortality, and how these mechanisms are shaped by the wider socio-political system in China. Socio-economic differentials in mortality are important, not only to those adversely affected by them, but also to policymakers intent on reducing social inequality and improving the health of a population.

In this paper we first review theories about and evidence on the relationship between SES and mortality and set out the conceptual framework underpinning our research. We then report the results of our study of the role SES plays in determining differentials in mortality among older people. Finally, in our concluding section we discuss some of the implications, and limitations, of our results.

2. Theory and evidence

2.1. Socio-economic differentials in mortality

Because a person's SES shapes his or her exposure to multiple health risks, it is a fundamental cause of mortality. It is also linked to the individual's ability to access a wide variety of resources, such as money, power, prestige, knowledge, and participation in a social network which will, in turn, affect whether he or she is likely to enjoy good health and a long life. The impact of the available resources will vary over time and in different social conditions (Link and Phelan 1995; Phelan et al. 2010) and can be manifested in a number of ways. Individuals belonging to higher socio-economic strata generally have better access to health care, especially preventative medical care (Blendon et al. 1989). Higher-SES individuals are not only able to afford better quality care, they are also better able to understand and follow any instructions given by their health care providers (Lutfey and Freese 2005). They are also almost always the first to take advantage of technological advances that improve health (Link et al. 1998; Glied and Lleras-Muney 2008; Chang and Lauderdale 2009). SES is also positively associated with better material living conditions, such that the well-to-do are more likely to enjoy safe water, good sanitation, adequate nutrition and sufficient clothing, and to live in well-built housing situated in a safe neighbourhood in a non-toxic environment (Anderson and Armstead 1995; Evans and Katrowitz 2002; Rosenbaum 2008). Note, however, that as lower-SES groups grow more prosperous and the impact of infectious diseases on mortality continues to decline, the importance of material conditions to the link between SES and mortality will diminish, particularly in developed countries.

Research on the mechanisms responsible for the link between SES and mortality highlights the important role played by psycho-social factors (Williams 1990; Mirowsky and Ross 1998), including the following: the individual's perception of mastery and control over events and situations; stress within a family, or within a particular residential or occupational environment; whether or not the individual feels socially integrated and has a support network in place; and the individual's health-related behaviours. The last two factors have received the most attention in previous research. Support networks, such as those provided by marriage, family, friendship, and community ties, can benefit the health and longevity of individuals by providing both emotional and practical support. They can encourage healthy behaviours, discourage unhealthy ones, and provide sources of health-related information (Smith and Christakis 2008; Rogers et al. 2013). By helping to maintain, or even improve, the quality of a person's social networks, higher levels of SES can provide more social support, either through more stable social ties or greater organizational involvement (e.g., club membership), thus ensuring better living conditions (Bishop 1980; Berkman and Glass 2000; Xie et al. 2003). In higher-SES groups, for example, spouses tend to be more emotionally supportive of

each other than in lower-SES groups, even when the negative association between SES and divorce is taken into account (Dohrenwend and Dohrenwend 1970). Moreover, the socio-economically advantaged live healthier lifestyles than the socio-economically disadvantaged: they are more likely to refrain from smoking, to drink alcohol in moderation, if at all, to exercise more frequently, and to maintain a 'healthy' weight (Cutler and Lleras-Muney 2010; Lantz et al. 2010; Pampel et al. 2010).

Despite the extensive literature documenting the association between SES and mortality in developed countries (Kitagawa and Hauser 1973; Feldman et al. 1989; Menchik 1993; Bassuk et al. 2002), the causal mechanisms which explain differences in cause-specific mortality by SES have yet to be identified. A notable exception is a very recent study by Rogers et al. (2013), which evaluates numerous explanations of the association between education and mortality among US adults aged 25 and above. Using the Third National Health and Nutritional Examination Survey (1988–94) Linked Mortality File, they found that the educational gradients in all-cause and cause-specific adult mortality in the USA were to a large extent explained by family income and health-related behaviour, and only weakly explained by the strength of social support networks or by physiological indicators such as the presence of 'inflammation'.

To our knowledge, only three studies have directly examined whether and, if so, how, socio-economic factors are associated with differentials in mortality among the elderly in China. In an analysis of people aged 60 and over in Wuhan, China from 1991 to 1994, Liang et al. (2000) found that the higher an individual's SES—as measured by their years of schooling, the 'luxury' household items (e.g., telephone and motorcycle) they possessed, and whether they lived in an urban area—the lower their risk of mortality. More recently, Zhu and Xie (2007) used pooled data from the 1998, 2000, and 2002 waves of the Chinese Longitudinal Healthy Longevity Survey to investigate the effect of SES on the oldest-old (80 years and older) population in China. The study found that education and urban residence were associated with significantly lower mortality among China's 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 socio-economic conditions on mortality and found that, in China, economic independence was significantly associated with mortality among those aged 65 and over. These studies also investigated whether the association between SES and mortality was mediated by a number of variables commonly examined in Western countries, including stress (Liang et al. 2000), social relations (Liang et al. 2000; Wen and Gu 2011), and health practices (Wen and Gu 2011). These three studies shed little new light on whether the SES gradient in mortality in China, and the factors associated with it, exhibit any unique patterns which were different from those observed in Western societies.

The aim of the study reported in this paper was to fill that gap in our knowledge by examining what is distinctive about the association between SES and mortality in contemporary China. We argue that the specific ways in which the SES–mortality relationship manifests itself will depend on the particular social and material circumstances in which the association is examined. In developed countries, all members of the general population usually have adequate access to health care thanks to government programmes or private insurance (Cockerham 2010). As a result, access to medical care is not the most important determinant of an individual's health in these countries; instead, individual-level behaviours play a more important role in the association between SES and mortality (Link and Phelan 1995). This helps to explain why previous discussions of the mechanisms underlying the link between SES and mortality in developed countries have rarely paid attention to the question of access to health care. In contrast, health-related behaviours do not seem to act as an important intermediate causal mechanism in the association between SES and health status in China (Beydoun and Popkin 2005). Given the country's recent rapid economic growth, the association between SES and health behaviours is often in the opposite direction from that commonly observed in developed countries such as the USA. Until recently, higher-SES groups in China were more likely than lower-SES groups to have unhealthy diets (containing large amounts of fat and sugar), to be obese, to smoke and drink more alcohol, and to be more sedentary (Du et al. 2004; Kim et al. 2004). In the last few years, however, the higher-SES groups have been gradually adopting lifestyle changes which favour better health.

One would expect access to medical care, rather than lifestyle differences, to be an important mediator of the SES–health association in China, since those higher in the social hierarchy are able to gain access to much better health care. In the early 1980s, the Chinese government implemented a series of market-oriented reforms in the country's health care system. These included a reduction in government

subsidies for health care, the demise of the Co-operative Medical System as the agricultural communes were dismantled, and the opening up of a market in expensive new drugs and technologies (Blumenthal and Hsiao 2005; Eggleston 2010). In China, medical facilities and professionals tend to be concentrated in the biggest cities, which exacerbate the problems of access to, and the affordability of, health care. From 1978 to 2008, spending per head on personal health services in China, net of inflation, grew at an annual rate of 7.76 per cent per annum, which was faster than the growth rate of income per head (Blumenthal and Hsiao 2005; Center for Health Statistics and Information, Ministry of Health of the People's Republic of China 2009; National Bureau of Statistics of China 2010). The 2008 National Health Service Survey yielded a number of findings that show how the cost of medical care affected its use: 9 per cent of respondents who reported being unhealthy in the previous 2 weeks had forgone health care because of its cost; among those who should have been hospitalized in the previous 12 months, 18 per cent had refused to be admitted owing to concerns about cost; among those who had been discharged from hospital in the previous 12 months, some 20 per cent had requested a discharge to reduce expenses; and 35 per cent of poor households reported experiencing poverty as a result of disease or injury (Center for Health Statistics and Information, Ministry of Health of the People's Republic of China 2009).

2.2. A decomposition of socio-economic disparities in mortality

Studies of the association between SES and mortality rarely compare and evaluate the causal mechanisms that underlie the relationship. To a large extent, the dearth of such research reflects the difficulty of decomposing the effects that can be attributed exclusively to each explanatory factor. In the previous literature the factors thought to explain the SES–mortality relationship have typically been accounted for by comparing the magnitude and significance of the SES coefficient before and after the inclusion of the suggested causal factors in a regression model (e.g., Rogers et al. 2013). When multiple factors are involved, as in the case of SES, it has not been possible to attribute to each factor its unique explanatory power because of the inter-correlation between the various explanatory factors.

While we too were not able to establish the explanatory power specific to each explanatory factor considered, we did succeed in estimating its maximum and minimum effect, or 'upper bound' and 'lower bound'. This kind of decomposition is not a new idea (see, e.g., Xie and Shauman 1998), but our study was the first to apply the strategy to an explanation of socio-economic differences in mortality.

In summary, the purpose of our study was to gain a more comprehensive understanding of socio-economic disparities in mortality among the elderly in China. To achieve this objective, we examined the risks of dying from 'all causes', that is, 'overall' mortality, and from specific groups of causes. To the best of our knowledge, this was the first study to investigate the SES–mortality association by cause of death in China. The association has been investigated in studies elsewhere. In a study 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. A study by Rogers et al. (2013) demonstrated that among adults in the USA, both cardiovascular and respiratory diseases contributed more than cancer to the disparities in overall mortality by educational level. This study also found that the mediating influences of medical care, material conditions, health behaviours, and social relations on the SES gradient in mortality also varied by cause of death. We set out to evaluate whether similar associations existed among the elderly in contemporary China.

3. Data, measures, and methods

3.1. Data

The data used in our research were drawn from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), conducted by the Center for Healthy Aging and Family Studies at Peking University and the Chinese Mainland Information Group. The CLHLS is a longitudinal survey with five waves. The first, baseline, survey was conducted in 1998 and four follow-up surveys were conducted in 2000, 2002, 2005, and 2008. The CLHLS drew a sample of elderly respondents from 22 of China's 31 provinces, using a multistage, stratified sampling strategy. For the first two waves of the study, the CLHLS focused on the oldest-old, those aged 80 and over. From 2002 onwards, younger elderly people, aged from 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.)

We restricted our analysis of the data to a sample of elderly persons aged from 65 to 105, and used the 2005 wave of the survey as our baseline population. The latter restriction was necessary primarily because the question concerning cause of death did not remain exactly the same in each of the follow-up surveys. For those dying between the first and second waves, the second and third waves, or the third and fourth waves, the CLHLS collected information on only their main cause of death; for those dying between the fourth and fifth waves, information on their specific causes of death was collected. Of the 15,355 respondents in the 2005 wave, 7,410 (48.3 per cent) were re-interviewed 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 provided an ideal data set for our study, its main advantage being the rich information it contained on individuals. This included measures of SES, and, if the individual died, the date of death and the underlying causes. The SES measures included level of education, degree of economic independence, and household income per head. The reliability of the data on cause of death is a key issue in China because not all deaths occur in hospital or in an alternative health establishment. We believe that the major causes of death found in our data set are reasonably reliable because about 80 per cent of those dying between 2005 and 2008 had received some form of medical treatment before death. Information about a person's death was gathered either from his or her death certificate or from the next of kin if a death certificate was unavailable. It was the longitudinal nature of the CLHLS that made it possible to evaluate the relative influence of possible causal pathways between characteristics of SES and mortality.

3.2. Measures

In our analysis, we examined the risk of mortality in the sample population in the period from 2005 to 2008. Along with overall mortality, we analysed four major underlying causes of death, which we categorized using the tenth revision of the International Classification of Disease (World Health Organization 2010). These categories were: 'circulatory diseases' (which included heart disease, hypertension, and cerebrovascular disease); 'respiratory diseases' (bronchitis, pneumonia, chronic obstructive pulmonary disease, and asthma); 'cancer' (in all locations); and 'diabetes'. These diseases are currently the four leading causes of death among the elderly in the USA (Heron 2012) and are also becoming increasingly important in China (Yang et al. 2008). Unfortunately, data limitations prevented us from examining different types of cancer separately. We recognize that not all cancers are equally preventable, and that the 'cancer' classification is therefore a crude one, but for the purposes of our study, the important distinction was that cancer is relatively less preventable than circulatory disease, respiratory disease, or diabetes.

SES is conventionally measured using 'level of education', 'income', and 'occupation', all of which have already been shown to be closely associated with mortality and health status in developed countries (House et al. 1990, 1994; Adler et al. 1994; Anderson and Armstead 1995; Williams and Collins 1995; Huisman et al. 2003). It is, however, quite possible that these measures do not play as important a role in less developed countries, and this may particularly be the case for the elderly in China. A person's level of education is an important SES indicator in China, but it varies little among the elderly in rural areas where most are illiterate. Income too is likely to be a poor measure of SES in China. Since most of the country's elderly withdraw from the labour market and rely heavily on their children for financial support, level of personal income is unlikely to capture the financial resources available to the elderly. Occupation was also found to be a poor measure of SES for our study. In part this is because most of the elderly people surveyed held the same occupation, that of 'peasant' (Zhu and Xie 2007), but also partly because the CLHLS measured occupation very crudely, providing only eight pre-fixed occupational categories for respondents to choose from. These eight occupational categories were (i) professional or technical personnel; (ii) governmental, institutional, or managerial personnel; (iii) agriculture, forestry, animal husbandry; (iv) fishery worker, industrial worker; (v) commercial or service worker; (vi) military personnel; (vii) housework; and (viii) others. Given the foregoing limitations of conventional indicators of SES for the population of interest, we decided to use one traditional indicator, 'years of schooling', combined with two alternative indicators: 'degree of economic independence' and 'household income per head'.

During the pre-communist era in China and in the years just after the transition to communism in 1947,

education was out of reach for most ordinary people. As a result, elderly people in the country today are generally not well educated. For this reason, we classified individuals as belonging to one of just two groups: those with 'no education' (illiterate elderly) and those with 'some education' (literate elderly). In earlier studies of the relationship between SES and health, based on data from the USA and Europe, education was widely used as an indicator of SES, and the overwhelming majority of these studies found education to be a strong predictor of health status and mortality rate. Some studies of China also used education as an indicator of SES when predicting health outcomes (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 mortality in old age and slowed decline in functional capacity.

We defined 'economic independence' as a dichotomous variable, coded 1 if the respondent was able to cover his daily expenses out of his retirement pension or some other form of income, and 0 if he could not. A study by Wen and Gu (2011) suggested that economic independence was associated with lower rates of mortality among the elderly in China.

In the 2005 wave of the CLHLS, 'household income per head' was directly assessed with the following question: 'What was the income per head of your household last year?' About 0.21 per cent of the respondents were coded as being in the topmost income category, indicating that the members of their household were each worth, on average, 'more than 100,000 yuan'. We followed standard practice (see, for example, Mouw and Kalleberg 2010) and replaced the value of the topmost income with 1.4 times its value. We also adjusted for any skewness in data on income per head by transforming it using the logarithm function.

In our study, we wished to investigate some of the possible mechanisms linking SES to mortality. The following three groups of variables have commonly been proposed as mediators between SES and mortality: (i) social relations, (ii) health-related behaviours, and (iii) access to and use of health care. In regard to social relations, we had information on current marital status (either 'married' or 'not currently married') for each individual in our sample, the number of their children who were still alive, and their proximity to each of those children. Elderly people who had at least one of their children living in the same household, in the same village, or on the same street were coded as having 'high proximity' to them; otherwise, they were coded as having 'low proximity'. For health-related behaviours we had information on whether or not an individual had ever smoked, had ever been a heavy drinker (defined as someone consuming more than 100 grams of liquor, 200 grams of wine, or 400 grams of beer or rice wine per day), and whether or not they exercised regularly. To gauge access to health care, the survey asked whether or not an elderly respondent was able to obtain adequate medical care if they fell seriously ill.

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

3.3. Analytical strategy

To explore how and why SES affects the individual's risk of mortality, we regressed 'date of death' on the predictor variables using Cox proportional hazards models. Follow-up was from 2005 and it was censored at the time of interview in 2008 or—in the cause-specific models—at the time of a death other than the one under consideration.

To reduce the influence of missing values on the outcomes of our analysis, we used a multiple-imputation procedure, deriving the missing values from ten random multiply imputed replications (Allison 2002). Among the variables in this study that were subject to multiple imputations the following proportions of missing values were found: 'years of schooling', 0.36 per cent; 'economic independence', 0.02 per cent; household income per head, 8.72 per cent; 'smoke', 0.01 per cent; and 'drink', 0.02 per cent. Those who were lost to follow-up (i.e., no survival information available in 2008) were excluded from our analysis. Preliminary results including the censored observations, survival statuses of which were imputed using multiple imputations, suggested that they showed comparable findings to those discussed here.

4. Results

4.1. Descriptive results

Table 1 provides descriptive statistics for all the variables for all 12,437 persons interviewed in 2005 (column 1) and for the 5,027 individuals who died during the follow-up period, that is, between the 2005 and 2008 waves of the survey (column 2). Percentage distributions are shown for categorical variables and mean values for continuous variables. Only 52.5 per cent of the respondents in 2005 had attended school, which is consistent with the findings of the 2005 mini census of China (National Bureau of Statistics of China 2007). The majority, some 74.5 per cent, of respondents were economically independent in 2005, with a mean household income per head of 2,445 yuan (shown as a log figure in Table 1).

A comparison of the two columns in Table 1 shows that those who died between 2005 and 2008 were, on average, less well educated, more likely to be economically dependent, and had lower than average household income per head. Those who were married had a larger number of children, had access to medical care in 2005, and were less likely to die in the following 3 years. Moreover, higher percentages of deaths occurred among those who reported in 2005 that they had ever been smokers or heavy alcohol drinkers, and those who had never taken regular exercise. However, the figures in Table 1 are simply bivariate tabulations and are strongly influenced by the age structure of the sample population. In order to see the risk of mortality from all causes, taking age and other covariates into account, we turn to Table 2.

4.2. Multivariate results

Table 2 presents the results of multivariate models of the association between SES and the risk of mortality from all causes. Model 1 displays the

Table 1 Descriptive statistics for variables[1] used in the analysis, Chinese Longitudinal Healthy Longevity Survey 2005–08

	Sample population from 2005 wave of CLHLS	Those dying 2005–08
Socio-economic conditions		
Per cent of the sample population who		
Were literate (had received 1+ years of schooling)	52.53	46.74
Were economically independent	74.46	69.60
Mean logged household income per head in 2005	7.80	7.72
Social relations variables		
Per cent of the sample population who		
Were currently married	61.82	53.13
Lived in close proximity with their children	76.52	77.68
Average number of living children in 2005	3.84	3.80
Health-related behaviours		
Per cent of the sample population who had		
Ever smoked	42.60	46.75
Ever been a heavy drinker	22.08	24.07
Ever exercised regularly	47.72	44.83
Access to health care		
Per cent of the sample population who had access	90.04	86.68
Sociodemographic variables		
Per cent of the sample population who		
Were female	51.35	49.74
Belonged to an ethnic minority	6.43	6.53
Lived in an urban area	39.10	39.13
Region: percentage living in		
East	41.94	37.59
Middle	26.29	30.41
West	31.77	32.00
Mean age	72.54	76.17
N	12,437	5,027

[1]Please see text for definitions of variables.
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 among the elderly, China 2005–08

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

[1]Please see text for definition of variables.
[2]Indicators of social relations are: current marital status, proximity to children, and number of living children.
[3]'Yes' indicates that the relevant variables are included in the model.
[4]Indicators of health behaviours are: ever smokers, ever heavy drinkers, and ever exercised regularly.
[5]Indicator of access to medical care is whether able to obtain adequate medical care.
Notes: The models also included age, sex, ethnicity, and region as covariates.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{+}p < 0.1$.
Source: As for Table 1.

relationship between SES and mortality, controlling for age, sex, ethnicity, residence, and region. Table 2 is consistent with the descriptive statistics presented in Table 1, in that it indicates that elderly people who were socio-economically advantaged in 2005 were less likely to have died before the follow-up survey in 2008. Elderly people with some education show a 3.2 per cent lower risk of dying between 2005 and 2008 than those with no education, although this difference was not significant at the 0.05 level. Economic independence provided a strong protective effect: elderly people who were economically independent had a 7.2 per cent lower risk of dying during the years between the 2005 and 2008 waves of the CLHLS than those who were dependent on their families for support. The estimated coefficient of logged household income per head was also statistically significant and negative, indicating that if an elderly person was a member of a household with higher income per head, their risk of mortality was reduced; in fact the risk of dying decreased 0.03 per cent for a 1 per cent increase in household income per head.

The remaining models in Table 2 reveal how the intervening mechanisms explain the effect of the SES variables on mortality among the elderly in China. Models 2–4 show the effects of social relations, health behaviours, and access to medical care, which are all commonly hypothesized to reduce the effects of SES on mortality. Models 2–4 test the effects of these three sets of possible mediating variables in sequence. Model 5 includes the full set of independent variables.

Of the three 'social relations' variables added in Model 2, only marital status is statistically significant. Married respondents in 2005 had a 14.5 per cent lower risk of dying than those not married. The association between SES and mortality was, however, relatively similar to that reported in Model 1, suggesting that 'social relations' fail to account for the link between SES and mortality. Because higher-SES elderly were more likely to abstain from smoking, to drink moderately, and to exercise regularly, when we controlled for health behaviours the association between 'economic independence' and mortality was attenuated. However, if we compare Model 3 with Model 1, we can see that the coefficients for the effects of 'education' and 'household income' hardly change. Thus, contrary to the findings of some other studies (e.g., Wen and Gu 2011), we found some evidence to support the expectation that SES affects mortality, in part, by enabling elderly people to improve their health-related behaviour and then maintain that good behaviour, thus lowering their risk of mortality. For those who stated in 2005 that they were able to access adequate medical care when they fell seriously ill, the risk of dying was 10.3 per cent lower than that for those who reported that they had no access to such care. When we included 'access to medical care', in Model 4, the coefficient for the effect of 'economic independence' was reduced by 37.3 per cent (Model 4 compared to Model 1) and failed to reach even the 0.1 per cent level of significance, although the coefficients for the variables 'literacy' and 'household income per head' changed slightly. The attenuated effects for those in the higher-SES group suggest that access to medical care played a part in lowering the risk of mortality in this group. Finally, when we controlled for all the mediating variables in Model 5 there were no statistically significant socio-economic differences in overall mortality.

Table 3 Cox proportional hazards regression coefficients predicting cause-specific mortality[1] among the elderly, China 2005–08

	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[2]		Yes[3]			Yes
Health behaviours[2]			Yes		Yes
Access to medical care[2]				Yes	Yes

[1]Please see text for the diseases included in the groups of causes.
[2]For an explanation of 'social relations', 'health behaviours', and 'access to medical care', please see Table 2.
[3]'Yes' indicates that the relevant variables are included in the model.
Notes: The models also included age, sex, ethnicity, and region as covariates.
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.1$; $N = 12{,}437$.
Source: As for Table 1.

Table 3 presents the results of models of SES and mortality from specific groups of causes, controlling for the same sets of independent variables included in the models of overall mortality. Although higher-SES elderly people enjoyed lower rates of overall mortality, this association did not always hold when different causes of death were taken into account (Model 1, Table 3). Like previous researchers (e.g., Phelan et al. 2004; Rogers et al. 2013), we found that SES was more strongly related to mortality from more preventable causes, such as circulatory and respiratory diseases, than to mortality from less preventable causes, such as cancer. Mortality from circulatory and respiratory diseases was higher among the lower-SES elderly than among the higher-SES elderly. For example, those elderly Chinese who were economically independent in 2005 had an 18.5 per cent lower risk of dying from circulatory disease and a 23.2 per cent lower risk of dying from respiratory disease within the period before the follow-up survey in 2008, than those who were economically dependent. The risk of dying from cancer did not differ significantly between the elderly in higher-SES groups and those in the lower ones. Contrary to expectation, diabetes in China seems to be a disease of the rich; persons of higher SES being more likely to die from this condition. Compared to those who had no schooling, those who had attended school had a 65.4 per cent greater risk of dying from diabetes. The elderly from higher-income families also had a higher risk of dying from diabetes than those from lower-income families. A possible explanation for the positive relationship between SES and diabetes is that the risk factors for diabetes, such as obesity, initially occurred with greater frequency among individuals of higher SES. It is possible that the SES gradient in diabetes mortality will reverse in the future.

Models 2–5 in Table 3 demonstrate the impact of the mediating factors on the association between SES and mortality from each cause of death. For each of the cause-of-death categories analysed, the inclusion of 'social relations' variables in Model 2 has relatively little influence on socio-economic differences in mortality. On the other hand, the inclusion of factors related to 'health behaviours' has an attenuating influence on the SES differences in the chance of dying from circulatory disease, respiratory disease, or diabetes, particularly when we compared those elderly persons who were economically independent with those who were not (Model 3 compared with Model 1). For example, when the 'health behaviours' variables are included, the difference between those who were economically independent

and those who were not is reduced slightly from 23.3 to 22.4 per cent. It is certainly possible that health-related behaviours affect the relationship between SES and mortality. For example, cigarette smoking is related to SES and also related to mortality from circulatory and respiratory disease as well as to mortality from diabetes.

'Access to medical care' was found to be a very important mediating variable for mortality from circulatory disease and from respiratory disease. A comparison of Model 4 with Model 1 shows that the inclusion of 'access to medical care' leads to a substantial reduction in the association between SES and mortality from both forms of disease. 'Access to medical care' makes a negative contribution to the relationship between SES and diabetes mortality, but this is more than outweighed by the positive contributions made by other mechanisms.

4.3. Decomposition of explanatory power

We next conducted a formal analysis to determine the unique contribution of 'social relations', 'health behaviours', and 'access to medical care' to the explanation of the mortality gap between high and low socio-economic groups. The method we used followed that described in Xie and Shauman (1998). We estimated Cox proportional hazard models to predict the risk of mortality in two starkly different situations and used the changes in the coefficients of the SES variables to measure the explanatory power of the individual factors involved. When an SES variable has a protective effect, its estimated coefficient in the Cox model, β_{ses}, should be negative. The lower bound of the effect of each variable is estimated from any decrease seen in β_{ses}, when an explanatory factor (the kth variable) is taken out of the full model, that is, Model 5, Table 2 in the case of overall mortality, or Model 5, Table 3 when cause-specific mortality is being considered. Expressed formally, the lower bound is obtained by the following equation (where the SES subscript following each β is omitted for clarity):

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

where β^5 denotes the SES coefficients for the full model and β^{5-k} denotes the SES coefficients for this model when the kth factor is excluded. It is argued that this equation captures the lower bound of explanatory effects because, if the kth factor is correlated with the other covariates included in the full model, then part of the explanatory power of the kth factor is already captured by the other covariates. Therefore, L captures any additional explanatory effects of the kth factor that are uncorrelated with any of the other factors.

The upper bounds of the effects of the SES variables are estimated from the increase in β_{ses} seen in the baseline model: either Model 1, Table 2 for overall mortality or Model 1, Table 3 for cause-specific mortality, after an explanatory factor (the kth variable) is added. This can be represented by the following equation (where again the SES subscript following each β is omitted for clarity):

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

Here U offers an estimate of the upper bound for the effect of the kth factor because part of the latter's explanatory power is captured by the other covariates with which it is correlated. Therefore U measures the maximum explanatory effects that can be attributed to the kth factor.

Table 4 presents the results of our decomposition analysis for overall mortality. In this table, we report the proportion of the socio-economic gradient in mortality that is explained both separately and simultaneously by 'social relations', 'health behaviours', and 'access to medical care'. Two findings stand out. First, the joint explanatory power, $[\exp(\beta^5) - \exp(\beta^1)]$, is very low when considering the gradient in mortality related to household income (0.5 per cent), but moderate for the gradients related to literacy and economic independence (around 3 per cent). Second, the relative importance of these three sets of factors in explaining the mortality gradient varies depending on the SES measure used. 'Health behaviours' explain a moderate part of the mortality gradient related to education (Columns 1 and 2, Table 4), while compared to 'social relations' and 'health behaviours', 'access to medical care' accounts for a larger proportion of the mortality gradient related to economic independence (Columns 3 and 4, Table 4). Since the effect of education on overall mortality net of economic independence and family income is not statistically significant (as shown in Table 2), we conclude that 'access to medical care' plays a more important role in explaining the association between SES and mortality than either 'social relations' or 'health behaviours'.

In Table 5 the results from the decomposition analysis for each of our cause-of-death groups are presented. Here, the joint explanatory power of 'social relations', 'health behaviours', and 'access to medical care' was generally higher for the economic-independence gradient in mortality than

Table 4 A decomposition of the socio-economic disparities in overall mortality among the elderly in China, 2005–08

	Literacy		Economic independence		Income	
Explanatory factors[1]	'Low'[2]	'High'[2]	'Low'	'High'	'Low'	'High'
Social relations	0.3	0.3	−0.3	−0.1	0.0	0.0
Health behaviours	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: $\exp(\beta^5) - \exp(\beta^1)$[3]	2.5		3.0		0.5	

[1]For an explanation of the explanatory factors, see Table 2.
[2]'Low' indicates lower bound and 'high' indicates upper bound estimates of explanatory effects. Lower bound estimates are based on the decrease in the coefficient of the SES variable after one category of explanatory factors is taken out of the full model (Model 5 of Table 2). Upper bound estimates are based on the increase in the coefficient of the SES variable after one category of explanatory factors is added to the baseline model (Model 1 of Table 2).
[3]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.

for the education or household-income gradients. Table 3 showed that of the three SES measures, only economic independence was a significant predictor of mortality from circulatory disease and respiratory disease. We therefore focus in Table 5 on the figures showing the explanatory power of 'social relations', 'health behaviours', and 'access to medical care' in relation to the mortality gradient for economic independence. As in the case of overall mortality, 'access to medical care' proves most important when explaining the association between economic independence and mortality from both circulatory disease and respiratory disease.

5. Conclusion and discussion

Using data from the 2005 and 2008 waves of the CLHLS, our study examined the association of three different SES indicators (education, economic independence, and household income per head) with mortality among the elderly in China. Our work has extended the previous studies of Liang et al. (2000), Zhu and Xie (2007), and Wen and Gu (2011) in three important ways. Firstly, it used a more recent data set, and the large, nationally representative sample of China's elderly population was drawn from a wider age range. Secondly, we have been able to explore whether the association between SES and mortality varied by cause of death in a non-Western country. Thirdly, using a decomposition analysis, we have been able to examine some of the possible causal mechanisms through which SES affects mortality.

One of our central findings has been that socio-economic differentials in mortality do exist among the elderly in China. Although often viewed as having distinctive social, cultural, and political systems, such as its Confucian ideology and the organization of the population into work units, China is not immune from the commonly observed positive association between mortality and SES, at both the personal and the household level. We found variations in the strength of the associations between different measures of SES and mortality, for example, the weaker association with education than with economic independence or household income per head. Whether or not economic dependence and household income per head were controlled, education was not significantly related to overall rates of mortality in this section of the population. This result runs counter to the conventional wisdom that educational attainment is an important predictor of mortality (Elo and Preston 1996; Rogers et al. 2013), and suggests that education is not a good proxy for SES among the elderly in China. While only a small proportion of people in China received a formal education in the early twentieth century, those without education could still be socially and economically successful, either through their work in agriculture or in skilled blue-collar work or by some other means. This probably explains why we found that economic independence and household income per head were both significant predictors of mortality rate in later life in China. It is therefore likely that the introduction of social policies that aim to reduce poverty will help to improve the health of the country's elderly population and also to reduce the socio-economic disparities in mortality which we have uncovered.

Another important finding from our study is that the association in China between SES and mortality varies by cause of death. Among those aged over 65 in China, SES was more strongly inversely related to mortality from more preventable causes than from less preventable causes. 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

Table 5 A decomposition of socio-economic disparities in cause-specific mortality[1] among the elderly in China, 2005–08

	Literacy		Economic independence		Income	
Explanatory factor[2]	'Low'[3]	'High'[3]	'Low'	'High'	'Low'	'High'
Panel 1: Circulatory disease						
Social relations	0.4	0.3	−0.9	−0.6	0.0	0.0
Health behaviours	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: $\exp(\beta^5) - \exp(\beta^1)$[4]	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 behaviours	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: $\exp(\beta^5) - \exp(\beta^1)$[4]	2.4		7.7		1.2	
Panel 3: Cancer						
Social relations	−1.7	−1.8	−0.1	−0.3	−0.1	−0.2
Health behaviours	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: $\exp(\beta^5) - \exp(\beta^1)$[4]	1.6		12.6		1.4	
Panel 4: Diabetes						
Social relations	−1.9	−2.4	−0.7	−0.7	−0.4	−0.5
Health behaviours	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: $\exp(\beta^5) - \exp(\beta^1)$[4]	1.3		13.5		2.2	

[1]Please see text for the diseases included in the groups of causes.
[2]For an explanation of the explanatory factors, see Table 2.
[3]'Low' indicates lower bound and 'high' indicates upper bound estimates of explanatory effects. Lower bound estimates are based on the decrease in the coefficient of the SES variable after one category of explanatory factors is taken out of the full model (Model 5 of Table 3). Upper bound estimates are based on the increase in the coefficient of the SES variable after one category of explanatory factors is added to the baseline model (Model 1 of Table 3).
[4]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.

evidence from studies of adults in Western societies (Phelan et al. 2004; Rogers et al. 2013).

In addition to exploring the overall impact of SES on mortality, we have also evaluated whether the associations may potentially be mediated by three causal mechanisms: the support networks provided by 'social relations', 'health behaviours', and 'access to medical care'. In line with previous research conducted in China (Wen and Gu 2011), variation in the set of variables we had available to represent an individual's access to social support failed to account for the association between SES and mortality among the elderly. Health behaviours, on the other hand, explained some portion of the association and it would appear that if the incidence of unhealthy lifestyles among the socio-economically disadvantaged could be reduced, social disparities in mortality would diminish. More importantly, our decomposition analyses have also indicated that people's access to medical care is of greater importance when accounting for the link between SES and mortality, than either the support networks they have available or their health-related behaviours. These findings sit in sharp contrast to those from studies based on data derived from developed countries. Most of the latter studies (e.g., Rogers et al. 2013) report that health-related behaviours have the strongest mediating influence on mortality. In addition, our analyses of cause-specific mortality demonstrate that in China the risk of death to the elderly in higher socio-economic strata has been reduced mainly by their greater ability to access medical care. It accounted for sizeable socio-economic gradients in mortality from both circulatory and respiratory disease. Because these two types of disease are currently the leading causes of death in China's elderly population (He et al. 2005), it is likely that a reduction in mortality from these two causes would substantially reduce social disparities in overall mortality.

Our findings suggest that improvements in access to medical care in China might directly increase life expectancy in the country, while also reducing social inequalities in mortality. Since the early 2000s, the Chinese government has established aggressive, state-run, health insurance programmes, and the population covered by such programmes has been expanded in both rural and urban areas (Li et al. 2011). In rural areas, the government introduced the New Rural Co-operative Medical Scheme while in

urban areas efforts have been made to expand the population covered by the Urban Resident Basic Medical Insurance Scheme. Together these two schemes constitute an important move forward, making medical care more affordable, and thus more accessible, to many members of the population (Wagstaff et al. 2009). Affordable, community-based services also need to be developed, so that the elderly can reap the greatest benefit from the improved access to health care. Our findings strongly suggest that life expectancy among the elderly in China would increase, and social disparities in health would decrease, if access to health care was improved.

While we believe that our findings provide new insights into the association between SES and mortality among the elderly, especially in China, we also need to acknowledge that our study had several limitations. First, it is possible that the individuals remaining in the sample were healthier than those lost to follow-up. Second, measures of SES and causes of mortality were based on proxy reports, and may have suffered from reporting errors. Third, owing to limitations present in the CLHLS, measures of the political factors known to have been of importance in post-Mao-era China were not available. Earlier research has shown that, despite the recent economic reforms which have moved the basis for social stratification away from the government and towards the market, political factors in China still play a large role in determining an individual's income, housing, health care, and pension (Bian and Logan 1996; Xie and Hannum 1996; Zhou 2000; Xie and Wu 2008), and therefore have an important influence on health outcomes among the elderly. We wish to encourage future researchers to examine how the unique structural dimensions of SES in China influence mortality within the country.

To conclude, our results show that SES is strongly associated with the risk of mortality among the elderly in China. Our results also show that the extent to which socio-economic factors affect mortality, and the mechanisms through which they do so, are shaped by the country's wider socio-political context. The influence of education on mortality is not as salient or as robust among China's elderly population as among their Western counterparts. Moreover, in contrast to developed countries, where health behaviours provide the most substantial explanation of the SES–mortality relationship, in China access to medical care is the most important mediator of this relationship.

We believe that those researching the association between SES and mortality and between SES and health conditions in general should pay greater attention to the wider socio-political context in which the effects of SES are being played out. We believe this also applies to those who are designing social policies to improve the health of a population and to reduce its health inequalities within it.

Note

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