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Socioeconomic Gradient in Old Age Mortality in Wuhan, China

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Objectives. The vast majority of studies on socioeconomic status (SES) and old age mortality are based on data derived from developed nations. This research examined the SES differentials in old age mortality in China, a developing nation.

Methods. Hazard rate models in conjunction with ordinary least squares and logistic regression analyses were used to ascertain the gross, direct, indirect, and interaction effects of SES on mortality during a 3-year period in a probability sample of 2,943 persons aged 60 years or older in Wuhan, China.

Results. Education, household economic well being, and urban-rural residence showed statistically significant gross effects on old age mortality. Education influenced mortality directly and indirectly. Household economic well being and urbanicity exerted indirect effects on mortality through mediating variables such as stress, social relations, and baseline health status. The mechanism through which education affected mortality differed between men and women, but SES differentials in mortality did not interact with age.

Discussion. SES differentials in old age mortality may be extended to a developing nation such as China. The observed gender by SES interaction effect on old age mortality has important implications for intervention. In particular, improving education among women in underdeveloped areas must remain a high priority, for policy makers in efforts to extend the life expectancy of women.

THERE is a well established inverse gradient between socioeconomic status (SES) and old age mortality (G. A. Kaplan, 1997; Martelin, 1994). However, this conclusion is almost exclusively based on research conducted in Western developed nations, particularly in the United States (see, e.g., Branch & Ku, 1989; Elo & Preston, 1996; Feldman, Makuc, Kleinman, & Cornoni-Huntley, 1989; Land, Guralnik, & Blazer, 1994; Schoenfeld, Malmrose, Blazer, Gold, & Seeman, 1994; Sorlie, Backlund, & Keller, 1995; Sugisawa, Liang, & Liu, 1994). Although these studies have provided important insights, their external validity needs to be carefully evaluated, because major health parameters exhibit different patterns in the Third World nations (Hunt & Annandale, 1999). A powerful strategy for establishing external validity is to undertake research in various societies with different cultures, social systems, and physical environments (Cook & Campbell, 1979). To the best of our knowledge, little empirical research has focused on the linkages between SES and old age mortality in developing nations. In the present research we examined the SES differentials in mortality during a 3-year period in a probability sample of 2,943 persons aged 60 years or older in Wuhan, China.

Given the substantial differences between its culture and social system and those of the developed nations, China is an ideal setting for further research on SES and old age mortality. China differs from the developed nations in several important respects, including population, health, economic development, and social organization. With a total population of more than 1.2 billion, China accounts for more than 20% of the world's population (U.S. Bureau of the Census, 1999). Although persons aged 65 or older constituted only 6.6% of its total population in 1995, China has the largest population of elderly people in the world, numbering 82 million. The proportion of aged people is projected to increase at an accelerated pace, reaching as high as 13–18% by 2050 (Grigsby & Olshansky, 1989).

In China, life expectancy at birth in 1997 was 69 years for men and 72 years for women (U.S. Bureau of the Census, 1999). Eighty percent of the population lives in areas where the epidemiological transition has already occurred; that is, chronic and degenerative diseases, rather than infectious diseases, are the major causes of death (Hsiao & Liu, 1996). Given the very limited health care personnel and facilities in China and a health expenditure per capita of U.S. $65 in 1993, the life expectancy of Chinese persons compares favorably to that of the people of other nations (World Bank, 1997a).

Chinese elderly people are not well educated, with 64% of them illiterate. Among rural elderly women in China, the literacy rate is only 11%. In contrast, less than 9% of aged people in the United States are illiterate (U.S. Bureau of the Census, 1999). There are also substantial differences in economic well being between China and the developed nations. In 1993 the per capita disposable income (income after taxes) was $1,308 in China versus $18,151 in the United

States, after adjusting for differences in prices of goods and services between these two nations (Hsiao & Liu, 1996; U.S. Department of Commerce, Bureau of Economic Analysis, 1995).

Compared with those in developed nations, elderly people in China have more children and are far more likely to reside with their children. In 1991, two thirds of those aged 60 or older lived with their children (Liang, Gu, & Krause, 1992). The pension system in China is a pay-as-you-go defined benefit system that covers mainly state sector employees in urban areas. Because pension programs are available to only 31% of the total labor force in China, many older persons depend on their children for significant financial assistance (Gu & Liang, 1994). This pattern of social support is reinforced by the norm of filial piety. According to the teachings of Confucius, adult children are expected to take care of the needs of their aged parents.

China also has a rather unique societal configuration that includes sharp disparities between urban and rural areas and a socialist economy with an emerging but fast-growing private sector. The Household Registration System was instituted in the 1950s for state economic planning and controlling rural to urban migration. Household registration was, until 1980, a prerequisite to an individual for obtaining education, employment, food, and daily necessities and even for getting married and rearing children. People belong to either agricultural or nonagricultural households, and this status is inherited from one generation to the next. With 75% of the population residing in rural areas, the urban-rural per capita income ratio was on the order of 2:1 in the 1950s and widened to 2.5:1 or even 3:1 in the late 1970s. During the same period, differences in the standard of living also widened sharply, despite the fact that gaps in education and health care declined somewhat (Whyte, 1995).

Between 1950 and the late 1970s, China had a planned socialist economy in that the state owned all resources, and resource transfers and social status were largely determined by political power rather than by market mechanisms. Under this system, income distribution among the vast working-class population was relatively egalitarian. Before 1978, most Chinese had a low standard of living, and income inequalities were of secondary importance to variations in access to public goods such as housing (Bian & Logan, 1996).

China began its transformation to a market-oriented economy in 1978. This transformation led to a significant improvement in the standard of living. Per capita disposable income increased 6.1% per year, after inflation, between 1980 and 1993, more than three times the rate in the United States (Hsiao & Liu, 1996). In addition, the reforms altered the occupational structure significantly, with the nonstate sector accounting for 70% of China's GDP in 1993. Although income inequality declined slightly during the first decade of reform, it then increased dramatically, with the Gini coefficient rising from 28.8 in 1981 to 38.8 in 1995 (World Bank, 1997b). The reform policies included no commitments to close the urban-rural income gap. In addition to the income gap, the rural-urban disparities in education and health care have increased even more (Whyte, 1995).

In summary, China presents many conditions not found in developed nations. It provides an interesting context for replicating prior observations made in the developed nations and may shed some light on the relationships between SES and old age mortality. Although several studies related to mortality in Chinese elderly people emerged recently, all were based on data derived from urban areas with a high standard of living, including Hong Kong (Ho, 1991), Shanghai (E. S. Yu et al., 1998), and Taiwan (Liu, Hermalin, & Chuang 1998). These areas resemble more the newly industrialized or developed societies than a developing country and do not include any of the 75% of the Chinese population residing in the rural areas. In addition, both Hong Kong and Taiwan have a system of political economy vastly different from that in the Chinese mainland. Finally, two of these three studies (Ho, 1991; E. S. Yu et al., 1998) did not focus on the effects of SES on old age mortality.

Model Specifications

Figure 1 explicates the hypothesized linkages among SES, stress and social relations, health, and mortality. The model consists of three major components. First, direct linkages are hypothesized between SES and mortality. Second, financial strain, social relations (i.e., social networks and social support), and health status are conceptualized as mediating the effects of SES on mortality. Third, age and gender are postulated as antecedent variables.

In Figure 1, urban residence, education, and luxury household items are included as measures of SES. Their inclusion reflects our conceptualization of SES as a multidimensional construct and the rather unique societal conditions in China. In particular, education, household economic well being, and urban or rural residence represents SES at the individual, household, and area levels (Feinstein, 1993; Krieger & Fee, 1994). As an indicator of SES, education has several advantages. It is causally prior to income and occupation and is stable throughout life after young adulthood. More importantly, it is a universal indicator of SES to all adults, whereas occupation is specific to those who are employed (Kitagawa & Hauser, 1973; Ross & Wu, 1996). Income was not used as a measure of SES, because many respondents were no longer working. Moreover, urban standards of living are much higher than the income data would suggest because of the large subsidies in housing, education, and health care (World Bank, 1997b). In rural areas economic exchange often does not involve currency. Consequently, instead of income, we used a count of the presence of 12 household luxury items (e.g., television, refrigerator, and car or truck) to assess household economic well being. Finally, given the substantial disparities between urban and rural areas in income and other dimensions of welfare, urban residence was employed as an indicator for SES.

In accordance with the current literature, an inverse relationship between SES and mortality is hypothesized. That is, urban residents, those with higher education, and those with more household luxury items would tend to have a lower risk of dying. There is also extensive research suggesting that old age mortality is influenced by a host of factors in addition to SES. These factors include age, gender, stress, social relations, and health status. In particular, old age and male gender are hypothesized to lead to a higher risk of dying. Similarly, those exposed to a higher level of

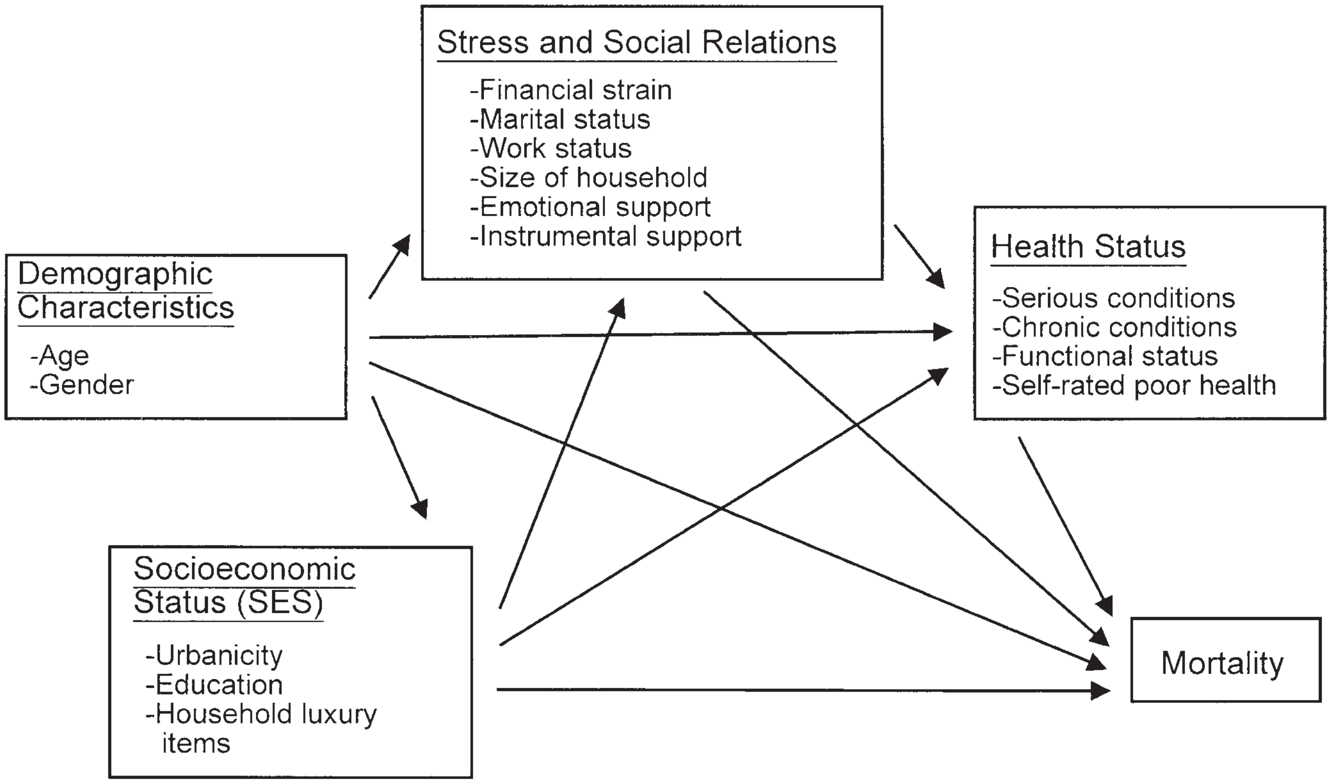

Figure 1. A conceptual model of socioeconomic differentials in mortality.

stress and with fewer social networks and less support are assumed to have a higher mortality (House et al., 1994). Furthermore, health status at baseline, including diseases, functional limitations, and self-rated poor health, is postulated to be associated with a greater risk of dying during the subsequent 3 years (Idler & Benyamini, 1997).

The predictors of mortality are interrelated. In particular, SES is a function of age and gender (O'Rand, 1996). Stress and social relations are affected by age, gender, and SES, whereas health status is affected by age, gender, SES, stress, and social relations (George, 1996; House et al., 1994). The theoretical rationale underlying the proposed framework stems from a sociomedical perspective of health. Consisting of sociocultural system, social status, and relationships, social structure is hypothesized to influence health via three categories of variables including (a) exposure to health-promoting or pathogenic circumstances, (b) ability to resist the exposure of risk factors, and (c) access to health care (H. B. Kaplan, 1989). House and his associates (1994) further explicated that social stratification of health and aging is produced by social and biological mechanisms influencing both the exposure to and consequences of a set of psychosocial variables. These variables include stress, social relations, health behavior, and sense of control.

Within the proposed framework, several research issues may be examined. First, the nature of the SES effects on mortality is often not well defined. The gross effects of SES on mortality are those found without controlling for other confounding variables. In multivariate analyses, the effect of SES on the risk of dying often represents the direct effect, net of the impacts of other covariates. Furthermore, SES may influence mortality indirectly through various mediating variables such as social relationships and baseline health status. There has been a fair amount of research on the gross and direct effects of SES on mortality, whereas little attention has been directed to its indirect effects.

This framework is congruent with recent calls for more attention to careful structural modeling of the underlying mechanisms that cause socioeconomic inequalities in health outcomes (Feinstein, 1993). Despite greatly increased specificity in recent sociodemographic studies of mortality, causal attribution is lacking. Sociodemographic factors might best be conceptualized as working through proximate determinants to mortality including behavioral, psychosocial, health care, and biological factors (Hummer, Rogers, & Eberstein, 1998). In many instances changes in one explanatory variable result in changes in other explanatory variables as well as in the dependent variable (Hanushek & Jackson, 1977). In this case, the total effect of an exogenous variable on the dependent variable includes not only the direct effect but also the indirect effect via other explanatory variables. These indirect effects may either reinforce or negate the direct effects of the initial explanatory variable. One of our major purposes in the present research was to highlight direct as well as indirect effects of SES on old age mortality.

Second, the multidimensional nature of social stratification has been increasingly recognized. In addition to social class, it is now common to conceptualize age and gender as alternative forms of social stratification (Lengermann & Niebrugge, 1996; Riley, 1987). Furthermore, there has been increasing interest in the interaction between the effect of SES on health and the effects of other dimensions of social status such as age and gender. For instance, House and his associates (1994) have argued that SES stratifies the way health varies with age. Similarly, Ross and Wu (1996) suggested that the health advantage of the well educated is larger in older groups than in younger groups. On the other hand, although it is well known that male mortality is higher than female mortality and that women report more acute illness and disability than men (Hunt & Annandale, 1999; Nathanson, 1977), there is limited understanding of how gender differences in health interact with SES. On the basis of data from developed nations, SES differentials are generally more pronounced among men than among women (see, e.g., Koskinen & Martelin, 1994). However, this conclusion has recently been questioned (Christenson & Johnson, 1995; McDonough, Williams, House, & Duncan, 1999). In the present study, we evaluated whether SES differences in mortality might depend on age and gender in an older population in China.

Methods

Sample and Data

Data for this research came from the 1991 Survey of Health and Living Conditions of the Aged in Wuhan, China, including the city proper and its surrounding suburbs and rural areas. Wuhan is the capital of Hubei province, which is part of the middle and lower Yangtze River basin in south central China. Wuhan is known as an agricultural center and for its major industries, including iron and steel works, shipbuilding and machinery, and textile and chemical manufacturing. The fifth largest city in China, Wuhan had a population of 4 million in its urban and suburban districts in 1990, and some 3 million people lived in the rural counties. Eight percent of the residents were aged 60 years or older in 1991.

The survey involved a three-stage probability sample of individuals aged 60 or older. Using the 1990 Chinese Census as the sampling frame and stratifying by administrative areas including seven urban districts, two suburban districts, and four rural counties, we selected 3,543 eligible respondents. Interviews were conducted in the respondents' homes and generally lasted between 1 and 2 h. With a response rate of 83%, interviews were completed with 2,943 individuals, including 178 proxy respondents.

Measures

The development of the questionnaire involved the translation of numerous scales and items from English into Chinese and their modification in response to the unique setting in Wuhan. Much effort was devoted to an intensive item-by-item examination. Many components of the questionnaire were field tested in two previous studies (Gu & Guo, 1989; Gu & Wang, 1989). In addition, the questionnaire was subjected to several critical evaluations including focus groups, two pretests, and a pilot study involving 50 elderly persons.

The survival status for each respondent was followed during a 3-year period, from 1991 to 1994. Of the 2,765 respondents who completed the baseline interview in 1991, 391 individuals (14%) died during the 3 following years. The time of death was recorded by the interviewer on the basis of information given by the appropriate proxy respondent (i.e., next of kin or neighbor). We verified deaths by checking against the Household Registration records, because vital events (i.e., birth, death, and marriage) are by law required to be reported to the local administrative units (i.e., neighborhood resident committees in the city and village offices in the countryside) and recorded in the Household Registration. In general, the quality of Household Registration information is better in urban areas than in rural areas. The increasing migration from rural to urban areas that has occurred since the economic reforms were enacted may also influence the quality of registration. However, reporting of old age mortality is less affected because elderly people are less mobile.

Three measures were used to represent SES. Urban residence was a dummy variable, with urban household registration coded as 1 and rural household registration coded as 0. Educational attainment was indexed by the total number of years in school. Household economic well being was measured by a count of the presence of 12 household luxury items, including telephone, motorcycle, black and white television, color television, refrigerator, washing machine, videocassette recorder, stereo, air conditioner, piano, bicycle, and car or truck.

Two demographic characteristics, age and gender, were included in the analyses. Age was measured in terms of the actual years of age at the time of survey. Gender was a dummy variable, with female coded as 1.

With reference to stress in old age, we focused on stressors related to finance. Three items of current financial difficulty (i.e., not having enough pocket money, dissatisfaction with financial situation, and how finances compare to like-aged others), were transformed into *z* scores and then summed to create a scale of financial strain ($\alpha = .715$). Marital status, size of household, and current work status were used as measures of social networks. Marital and working status were treated as dummy variables, with currently married and currently working both coded as 1. Size of household was defined as the number of persons living in the household, including the respondent. Measures of social support included emotional as well as instrumental support items. These items were derived on the basis of current conceptualization and a series of factor analyses (Liang, et al., 1992). Emotional support consisted of a composite of two 5-point items assessing (a) the amount of love and caring the respondent can expect from his or her significant others and (b) the willingness of significant others to listen to the personal problems and inner feelings of the respondent. We summed the two emotional support items ($r = .415$) to form a composite. Instrumental support comprised two 5-point items indicating the amount of sick care and financial assistance the respondent can expect from his or her significant others. We summed the two instrumental support items ($r = .465$) to form a composite. Higher scores for both composites represent more support received.

Health status was assessed by measures of morbidity, functional status, and self-rated health. First, information on morbidity was derived from a checklist of 24 conditions. We generated an index of serious conditions, including cancer, diabetes, heart disease, hypertension, and stroke; the remaining conditions were classified as chronic conditions (Ferraro & Farmer, 1999). Second, we used measures of functional limitations (i.e., crouching, grasping, lifting, and reaching) and activities of daily living (i.e., bathing, climbing stairs, walking a half mile, managing one's money, shopping, and traveling by bus or boat) to create an index of functional status. *Z* scores for these two kinds of measures ($r = .712$) were computed and then summed. Finally, self-rated health was assessed as a composite of the *z* scores from four indicators including an overall rating of physical health, health comparisons to other people one's age and to one's health a year prior, and a report of overall satisfaction with one's health ($\alpha = .759$).

Data Management

To minimize the loss of cases, we imputed missing values whenever possible. The highest prevalence of missing values was found among the time of death indicators. For 38 of the 391 decedents, time of death was missing. For another 37, the month but not the year of death was missing. In these cases, death was assumed to occur at the midpoint of the possible range. To assess the influence of this assumption, we also imputed the time of death randomly four times (Dorey, Little, & Schenker, 1993). We compared results obtained using the original imputation method to the four data sets created using a random imputation function. No significant differences were found in the pattern of results.

To maximize the response rate, we administered an abbreviated version of the survey questionnaire to a proxy respondent when the selected respondent could not complete the full interview for a variety of reasons, including physical illness, hearing problems, or mental problems. A total of 178 proxy respondents were identified at the onset of or during the interview. Proxy responses differed substantially from the self-responses (Table 1). In particular, the death rate among those interviewed by proxies was more than three times as high as that among the self-respondents (43.1% vs 12.4%). Furthermore, self-respondents were likely to be younger, male, better educated, married, working, and living in a larger household and to have better functional status. As a result, it is important to assess the bias caused by the exclusion of proxy interviews in the analysis.

Data Analysis

We used Cox regression analyses to ascertain the direct and indirect effects of SES on mortality, and we used ordinary least squares regression and logistic regression to assess the interrelationships among the covariates. The bulk of the analysis was done on the data collected from the self-respondents. To assess the potential bias caused by the exclusion of proxy responses, findings from data on self-respondents were contrasted with the results involving both proxy and self-respondents.

Results

Gross Effects

The gross effects of all variables as the only predictor of the risk of mortality without controlling for any other variable are listed in Table 2, under the column of bivariate regressions. SES variables all show a significant gross effect on mortality. To illuminate the effects of SES on the risk of dying, one may examine the antilogarithm of the unstandardized regression coefficients (e^b), often referred to as hazard ratios or relative risk ratios (Table 2). In particular, an older person residing in an urban area was 27% less likely ($e^b = .729$) to die than someone who lived in a nonurban

Table 1. Differences Between Self- and Proxy Respondents on Variables in the Analyses

Variable	Self-Respondents (n = 2,765) *M*		Self-Respondents *SD*	Proxy Respondents (n = 178) *M*		Proxy Respondents *SD*
Survival (months)	33.696***		6.741	29.073		10.815
Mortality (dead = 1)		14.1%***			39.3%	
Age (years)	68.760***		6.098	73.101		8.300
Sex (female = 1)[a]		54.4%**			65.2%	
Urbanicity (urban = 1)[a]		55.3%			56.7%	
Education (years)[b]	2.569**		3.949	1.733		3.345
Luxury items	2.592		1.914	2.556		1.878
Marital status (married = 1)[a]		61.5%***			46.6%	
Work status (currently works = 1)[a]		32.3%***			9.6%	
Size of household	3.778*		2.026	4.174		2.175
Number of serious (life-threatening) health conditions	.501***		.730	.803		1.014
Number of chronic (non-life-threatening) health conditions	2.765		1.857	2.781		1.923
Functional status						
Activities of daily living limitations	1.177***		1.720	3.598		2.340
Functional limitations	9.28***		1.206	2.169		1.571

[a]Chi-square test was used instead of *t* test.

[b]2 cases missing.

[c]8 cases missing.

*$p < .05$; **$p < .01$; ***$p < .001$ (2-tailed test).

Table 2. Unstandardized Estimates From Cox's Regression Block Analyses of Old Age Mortality in Wuhan (N = 2,745)

	Bivariate		Demographics (df = 2)		Socioeconomic Status (df = 3)		Stress and Social Relations (df = 6)		Health (df = 3)	
Independent Variable	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)
Age	.095***	1.100	.102***	1.108						
Sex (female = 1)	−.343***	.709	−.548***	.578						
Urbanicity (urban = 1)	−.316**	.729			−.165	.848				
Education	−.054***	.947			−.042*	.959				
Luxury items	−.073**	.930			−.027	.972				
Financial strain	.069***	1.072					.031	1.032		
Marital status (married = 1)	−.467***	.627					−.313**	.731		
Work status (currently works = 1)	−.595***	.552					−.502***	.606		
Size of household	.015	1.015					.031	1.032		
Emotional support	−.120***	.887					−.086**	.917		
Instrumental support	−.056*	.945					−.015	.985		
Number of serious health conditions	.315***	1.371							.079	1.083
Number of chronic health conditions	.017	1.017							−.087**	.917
Functional status	.306***	1.358							.231***	1.260
Self-rated poor health	.172***	1.188							.098***	1.103
−2 LL without covariates			6073.330***		6073.330***		6073.330***		6073.330***	
−2 LL with covariates			5891.578***		6054.887***		6012.303***		5899.777***	
Model chi-square			181.752***		18.443***		61.026***		173.553***	

* $p < .05$; ** $p < .01$; *** $p < .001$ (2-tailed test).

area. Likewise, each additional reported year of education was associated with a 5% reduction in risk of mortality (e^b = .947), and the possession of each additional luxury item resulted in an associated 7% decrease in risk of dying (e^b = .930).

As expected, age and sex also exhibited statistically significant gross effects, with increased age (e^b = 1.100) related to a higher risk of mortality and being female (e^b = .709) showing a reduction in the risk of mortality. Consistent with current literature, financial strain was associated with an increased gross risk of dying (e^b = 1.072), and all social relations measures except size of household were significantly related to a decreased risk of mortality. Specifically, being married (e^b = .627), currently working (e^b = .552), and higher levels of emotional support (e^b = .887) and instrumental support (e^b = .945) tended to lower the risk of subsequent mortality. For health status, greater numbers of serious health conditions (e^b = 1.371), more functional limitations (e^b = 1.358), and self-rated poor health (e^b = 1.188) were all predictors of higher mortality. However, chronic conditions did not show a significant impact on mortality.

Direct and Indirect Effects

The effects of the various predictors of mortality were subsequently examined within each conceptual block so that the correlations among variables within the same block were controlled (Table 2). Results from the demographic block containing age and sex were basically the same. With regard to the block containing the SES variables, when urbanicity, education, and luxury items were all entered, only the effect of education (e^b = .959) remained significant. This may be due to the substantial correlations between urban residence and luxury household items (r = .500). As for the effects of the block of stress and social relations variables on mortality, the results were somewhat similar to the findings of the bivariate analysis. However, financial strain and instrumental support were no longer significant because of their correlations with the other social relations variables. For instance, there was a significant correlation between emotional and instrumental support (r = .451). In addition, financial strain was significantly correlated with emotional support (r = −.298) and instrumental support (r = −.268). When we used the entire block of health status variables to predict mortality, functional status and self-rated ill health remained significant, whereas serious health conditions no longer showed a significant effect, and chronic conditions were associated with a reduced risk of dying (e^b = .917).

Finally, the effects of SES and other determinants on mortality were analyzed with Cox regression analysis hierarchically (Table 3). Specifically, measures of demographics and SES were entered as predictors of mortality (Table 3, columns 2 and 3). Subsequently, we evaluated the effects of SES by controlling for the effects of intervening variables, including financial strain and social relations first (Table 3, columns 4 and 5) and then adding the block of health items to the equation (Table 3, columns 6 and 7). By analyzing the stability and change in the relative risk ratios across the hierarchical regressions, one may gain some insights concerning the direct as well as indirect effects of the predictors of mortality (Tables 2 and 3).

As various covariates were brought into the equations, the relative risk ratios associated with age and gender diminished somewhat but remained quite robust. This suggests that age and gender differences in mortality were substantial, and they could not be explained by intervening variables including SES, stress, social relations, and baseline health conditions.

Table 3. Unstandardized Estimates From Cox's Regression Hierarchical Analyses of Old Age Mortality in Wuhan ($N = 2{,}745$)

Independent Variable	Demographics and SES ($df = 5$)		Demographics, SES, and Stress and Social Relations ($df = 11$)		Demographics, SES, Stress and Social Relations, and Health ($df = 15$)		Demographics, SES, Stress and Social Relations, Health, and Interactions ($df = 21$)	
	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)
Age	.099***	1.104	.086***	1.090	.079***	1.082	.074***	1.077
Sex (female = 1)	−.714***	.490	−.806***	.447	−.911***	.402	−.865***	.421
Urbanicity (urban = 1)	−.233*	.792	−.333*	.717	−.216	.806	−.857	.424
Education	−.059**	.943	−.054**	.948	−.043*	.958	−.000	1.000
Luxury items	.019	1.019	.031	1.031	.048	1.049	.047	1.048
Financial strain			.018	1.018	−.033	.968	−.032	.968
Marital status (married = 1)			−.049	.952	−.044	.957	−.035	.965
Work status (currently works = 1)			−.453**	.636	−.121	.886	−.128	.880
Size of household			.008	1.008	.003	1.003	.002	1.002
Emotional support			−.047	.954	−.023	.977	−.021	.979
Instrumental support			−.028	.973	−.021	.980	−.021	.979
Number of serious health conditions					.185**	1.203	.185**	1.204
Number of chronic health conditions					−.047	.954	−.042	.959
Functional status					.109**	1.115	.109**	1.115
Self-rated poor health					.127***	1.135	.127***	1.135
Age × Education							−.000	1.000
Gender × Education							−.141*	.869
Age × Luxury items							−.000	1.000
Gender × Luxury items							.058	1.059
Age × Urbanicity							.010	1.010
Gender × Urbanicity							−.122	.885
−2 LL without covariates	6073.330***		6073.330***		6073.330***		6073.330***	
−2 LL with covariates	5871.952***		5849.803***		5755.968***		5748.465**	
Model chi-square	201.378***		223.527***		317.362***		324.865***	

Note: SES = socioeconomic status.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$ (2-tailed test).

Given the multidimensional nature of SES, the effects of education differed somewhat from those of urban residence. When age and gender differences on mortality were controlled, the net effects of education remained statistically significant, indicating that educational differences in mortality were not due to population heterogeneity in age and sex composition. Moreover, education had a direct net effect on old age mortality ($e^b = .958$), although educational differences in old age mortality were partially mediated by stress, social relationships, and baseline health conditions.

On the other hand, demographic characteristics, financial strain, and social relationships appeared to exert suppressive effects on the association between urbanicity and mortality. That is, the relative risk ratio associated with urban residence was not statistically significant when education and luxury household items were controlled (Table 2). However, urban-rural differences in old age mortality became statistically significant at the .05 level and somewhat greater when age, gender, stress and social relations were controlled (Table 3). Nevertheless, the net effect of urbanicity on mortality could be explained by the differences in baseline health status such as functional status and self-rated ill health.

Across all models, household luxury items did not exert a statistically significant net effect on the risk of dying. This was largely due to the fact the possession of luxury household items was substantially correlated with education ($r =$ .294), urbanicity ($r = .500$), and household size ($r = .428$) in that 46% of its variance was explained by these three variables.

When demographic and SES variables were controlled, employment continued to show a protective effect, whereas the initially observed effects of marital status and emotional support on mortality were no longer statistically significant. In the full model containing demographic characteristics, SES, stress, social relations, and baseline health status, serious health conditions ($e^b = 1.203$), functional status ($e^b = 1.115$), and self-rated health ($e^b = 1.135$) all showed significant direct net effects on the risk of dying (Table 3). However, within the same equation, financial strain and social relations measures did not show any direct net effects on mortality. This suggests that the gross effects of financial strain and social relations variables were largely due to the population heterogeneity in age, gender, and SES. Furthermore, the direct net effect of work status on mortality was explained by differences in baseline health status.

To obtain further insights concerning the indirect effects of SES on mortality, we examined the relationships between SES and intervening variables such as stress and social relations and health (Table 4). According to our model, SES variables indirectly impacted the risk of dying via two mechanisms. First, urbanicity, education, and luxury items impacted mortality indirectly via their effect on serious health conditions, functional status, and self-rated health.

Table 4. Unstandardized Estimates From Regression Analyses of Functional Status and Self-Rated Health in Wuhan (N = 2,745)

Independent Variable	Financial Strain	Marital Status[a]	Work Status[a]	Emotional Support	Instrumental Support	Serious Health Conditions	Functional Status	Self-Rated Poor Health
Age	.017*	−.132***	−.145***	−.039***	.003	−.000	.094***	.001
Sex (female = 1)	.361***	−1.156***	−1.463***	.117	.451***	.125***	.466***	.401***
Urbanicity (urban = 1)	−.687***	.355***	−1.215***	−.174*	−.668***	.105**	−.176*	−.773***
Education	.009	.053***	−.003	.052***	−.007	.009*	−.025**	−.033*
Luxury items	−.308***	.033	−.070*	.138***	.270***	−.001	−.018	−.131***
Financial strain						.017**	.090***	.298***
Marital status (married = 1)						.077*	−.024	.197
Work status (currently works = 1)						−.213***	−.694***	−1.205***
Size of household						−.004	.025	.041
Emotional support						−.001	−.055***	−.133***
Instrumental support						−.009	−.020	−.086***

[a]Logistic regression was used instead of OLS.
* $p < .05$; ** $p < .01$; *** $p < .001$ (2-tailed test).

Specifically, residing in an urban area and having higher levels of education reduced functional limitations, whereas residing in an urban area, having higher levels of education, and possessing more luxury items reduced self-rated poor health, in turn decreasing the risk of mortality. Second, SES indirectly affected the risk of dying via its impact on stress and social relations and their subsequent impact on health status. For instance, higher levels of education were related to increased emotional social support ($b = .052$), which in turn was associated with improvements in functional status limitations and self-rated poor health.

The findings described thus far are all presented as unstandardized regression coefficients. Because of the different metrics associated with various variables, the relative magnitudes of their direct effects are difficult to discern. Consequently, we computed standardized regression coefficients by multiplying the unstandardized coefficients by the standard deviation of the covariate (see Selvin, 1991). Among the major determinants of old age mortality, age ($B = .478$, $e^B = 1.613$) and gender ($B = -.454$, $e^B = .635$) had the largest direct effects, followed by self-rated poor health ($B = .371$, $e^B = 1.449$). The effect of education ($B = -.170$, $e^B = .844$) was similar in magnitude to those of serious diseases ($B = .136$, $e^B = 1.145$) and functional status ($B = .188$, $e^B = 1.207$).

Interaction Effects

To explore the SES differences in old age mortality with respect to age and gender strata, we formed six interaction terms between SES variables (i.e., urban residence, education, and household luxury items) and strata variables such as age and gender. As shown in column 4 of Table 3, none of the interaction terms involving age and SES variables were statistically significant at the .05 level. Thus, the hypothesis of cumulative advantage of education across age (Ross and Wu, 1996) was not supported by data in this study.

On the other hand, there was a statistically significant interaction effect involving gender and education ($e^b = .869$ in Table 4). To obtain additional information, we performed further analyses on the male and female subsamples separately (results not shown). First, the average education for older men was more than three times that for elderly women (i.e., 4.163 years vs 1.226 years). Second, the gross effect of education on old age mortality among women ($e^b = .782$) was more than three times as large as that among men ($e^b = .940$). Each additional year of formal schooling reduced the relative mortality risk by 6% among men and by 22% among women. Third, when all the antecedent and intervening variables were controlled, the marginal effect of 1 additional year of education remained very strong ($e^b = .843$), whereas among older men the net direct effect of education was not significant at the .05 level. Among older men, the effect of education was completely mediated by financial strain and social relations (results not shown). Among elderly women, the effect of education remained quite robust even when stress, social relations, and baseline health status were controlled.

Another way to highlight the education by gender interaction effect on mortality among older people in China is to compare the survival functions for different gender and education subgroups. Statistically significant effects on the hazard rates may not necessarily translate into meaningful differentials in survival, depending on the magnitude of baseline mortality rate (Teachman & Hayward, 1993). On the basis of the full model (Table 3, column 3), Figure 2 displays the proportions of survivors during a period of 36 months at four levels of education for both men and women. The four levels of educational attainment included illiterate, 2.5 years (i.e., mean education for the sample), 6 years (i.e., primary school), and 12 years (i.e., high school). The gender differences in the effects of education on survival were quite apparent in that educational differentials were much greater among women than men.

Replication With Proxy Interviews

Bias due to the exclusion of proxy respondents was a concern in the current study. To assess such bias, we replicated the Cox regression analyses by including 2,765 self-respondents as well as 178 proxy respondents and by using a subset of the covariates without several measures based on self-report. Specifically, measures of current financial strain, emotional and instrumental support, and self-rated health were not included. In addition, a dummy variable indicating whether a respondent was a self-respondent was included. The results were replicated in that being older, male,

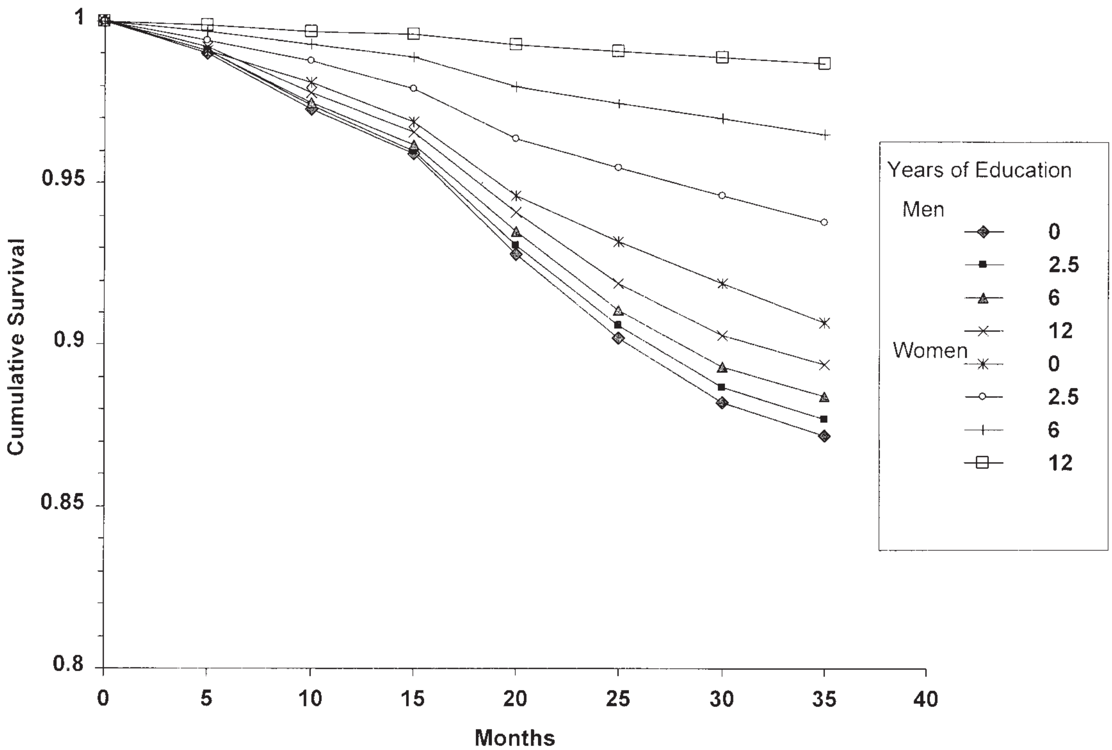

Figure 2. Educational differentials in mortality by gender.

and less educated and having more functional status limitations were associated with a greater risk of dying, which was revealed in an analysis of the sample consisting of only self-respondents. Finally, being a self-respondent at the baseline was significantly associated with a lower risk of dying during the subsequent 3 years. This is very likely a reflection of the better health status enjoyed by the self-respondents in general.

Discussion

A major contribution of the present research is that it provides new information concerning the linkages between SES and old age mortality in a developing nation such as China. Our results show that urban residence, education, and household luxury items all have statistically significant gross effects on mortality. These convergent findings provide some evidence that the socioeconomic gradient in mortality observed in the developed nations can be generalized to developing nations. Furthermore, various measures of SES have distinct direct and indirect effects on old age mortality. When all antecedent and mediating variables are controlled, education has a direct net effect on mortality, whereas urbanicity and luxury household items no longer show any direct net effect. In addition, SES can indirectly impact the risk of dying via stress, social relations, and health status.

Consequently, investigators need to be sensitive to the multidimensional nature of SES. Whenever possible, multiple measures of SES should be employed. More important, attention should be given to the gross, direct, and indirect effects of SES on old age mortality. Given the current state of knowledge, it is no longer sufficient to assert merely that a socioeconomic gradient in old age mortality exists. Researchers need to learn more about the underlying mechanisms and to specify the conditions and circumstances under which SES may make a difference in mortality. In this regard, analyzing data from the Third World countries would be particularly useful in supplementing observations made in the developed nations.

One of our major purposes in this research was to explore the differential SES effects on mortality in relation to age and gender. Several recent studies have offered evidence for the hypothesis of cumulative advantage of education on health (e.g., House et al., 1994; Ross & Wu, 1996). However, these studies focused on health measures such as functional limitations and self-rated health among adults in the United States. It would be instructive to determine whether similar evidence may be obtained with reference to old age mortality in a developing nation. No interaction effects involving age and SES measures were found in the present analysis, raising some questions about the generalizability of prior findings on old age mortality.

However, this study constituted a somewhat limited test of the initial hypothesis of cumulative advantage of education on health, because our data were derived entirely from persons aged 60 years or older. The educational levels of the survivors aged 60 or older might be quite different from those of the cohort at earlier ages. According to the theory of cumulative advantage of education on health, SES differentials in health would be smaller at younger ages than at older ages. This would imply that the educational levels of the survivors are not substantially different from those of the cohort at younger ages. However, it is difficult to evaluate this hypothesis because of the lack of data on those aged less than 60 years. Furthermore, the length for the period of mortality follow-up may not be sufficient to detect the hypothesized interaction effect. Ideally, researchers should analyze mortality across the life course by following one or more cohorts over an extended period of time. The selection effect and the possibility of a time varying effect of SES and other covariates on mortality could be examined. Our conclusions can apply only to a sample of Chinese people who survived to 60 years of age. It goes without saying that our findings need to be replicated in other older populations, particularly those in the developing nations.

An interesting finding of this study concerns the different mechanisms through which education affects old age mortality among men and women. Our findings are in sharp contrast with those based on data derived from the developed nations, because most studies have reported stronger socioeconomic effects for male mortality (Koskinen & Martelin, 1994). To place these findings in an appropriate context, it is useful to reflect on the differences between the present research and other studies. Among studies concerning gender differences in the effects of SES on mortality, the vast majority did not focus on the elderly population. Moreover, in these studies key intervening variables such as stress, social relations, and baseline health status were often not controlled (Christenson & Johnson, 1995; Koskinen & Martelin, 1994; Martelin, 1994; McDonough et al., 1999). Finally, gender disparities in education in developed nations are far less than those found in a developing nation such as China. To the best of our knowledge, this study is among the first in reference to gender differences in the linkages between education and old age mortality in a developing society.

There are several possible reasons why education exerts such differential effects between older Chinese women and their male counterparts. The difference may be due to the fact that the effect of education on survival diminishes as one becomes more educated. In China, 23% of the older men and 76% of the older women were illiterate in 1991. Furthermore, the average education for older men in our sample was more than three times that for elderly women (i.e., 4.163 years vs 1.226 years). Given the very low average education and its skewed distribution among elderly Chinese women, the marginal educational benefits in survival are likely to be quite substantial. Because older Chinese men have a much higher average education, the marginal effect of education on survival is still significant but more moderate.

There are several studies that did not support the general observation that SES differentials are greater among men than among women in the developed nations (Christenson & Johnson, 1995; Martikainen, 1995; McDonough et al., 1999). Our results are consistent with findings reported by some of these researchers. By matching death certificates to the 1960 U.S. Population Census schedules, Kitagawa and Hauser (1973) found that the returns to longevity from education were generally greater for women than for men. This larger education differential for women can be entirely attributed to the very high mortality of women in the lowest education group (i.e., less than 5 years of school). Recently Christenson and Johnson (1995) reported that women in Michigan derived greater survival benefits than men from obtaining a secondary education, but men derived larger survival benefits than women from obtaining postsecondary education. They suggested that increments in education might not favor men or women uniformly.

The epidemiological transition is already well advanced in most parts of China in that infectious diseases have decreased to a point where the chief causes of premature death and disability are chronic diseases. Accordingly, many of the most important health priorities involve the control of chronic diseases in middle and old age (World Bank, 1992). Hence, the analysis of old age mortality is timely. To further the understanding of the linkages between SES and mortality, researchers should investigate how and why SES is related to specific causes of death. This information is important for understanding the pathways responsible for mortality differentials. For instance, in the United States, about 40% of the sex mortality differentials is due to ischemic heart disease alone (Knudsen & McNown, 1993).

Similar questions may be posed concerning the SES differentials in the incidence, duration, and trajectory of morbidity, impairment, functional limitation, and disability. For instance, does an inverse relationship imply reduction or delay in the incidence of heart disease among the more educated, or does it mean only that the more educated survive longer after onset? Do better educated survivors have increased impairment and functional limitations? More important, disease, impairment, functional limitations, and disability may be tied to mortality in terms of active life expectancy (Hayward, Crimmins, & Saito, 1998; Land et al., 1994). Further relation of these data to various health behaviors and risk factors would help in the design of interventions for health promotion and disease prevention.

This research also demonstrates the importance of examining the intersection between societal conditions and biological differences. Variables such as age and gender encompass biological and social dimensions. At issue is whether the observed age and gender differences in morbidity and mortality stem chiefly from innate factors or reflect social divisions as mediated by SES. In this respect, a life course perspective (Hagsted, 1990) in conjunction with the framework of social stratification would be most useful.

The health status of China's population has improved enormously since 1949, but disparity in health between men and women still persists (M. Y. Yu & Sarri, 1997). The observed gender by SES interaction effect on old age mortality has important implications for intervention. In particular, improving education among women in underdeveloped areas must remain a high priority for policy makers not only in reducing infant and maternal mortality but also in extending life expectancy among women. As suggested by Kitagawa and Hauser (1973) more than 25 years ago, perhaps the next important gain in mortality reduction will be achieved through improvements in SES rather than increments to and applications of biomedical knowledge.

Although this study represents an important step toward the understanding of old age mortality in developing nations, more research is needed. Given the multidimensional nature of SES, one may wish to examine the interaction effects involving different SES dimensions. For instance, there is some evidence that the SES differential in mortality is less strong in rural areas compared with urban areas in the

United States (Hayward, McLaughlin, & Pienta, 1997). This is a very interesting research question, but it cannot be adequately addressed within the context of the current study. Further research replicating such findings in developing nations is definitely warranted.

Finally, it is conceivable that reciprocal relationships may exist among stress, social support, and health status within our proposed framework (Figure 1). In particular, major health changes may be conceptualized as stress. Sickness may reduce social networks and elicit more social support (Pruchno, Michaels, & Potashnik, 1990). Because stress, social support, and health status are specified as intervening variables between SES and old age mortality, the existence of these reciprocal linkages should not significantly affect the assessment of the effects of SES.

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