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Mortality of the oldest old Chinese: The role of early-life nutritional status, socioeconomic conditions, and sibling sex-composition

Cheng Huang[1] and **Irma T. Elo**[2]

[1] Emory University

[2] The University of Pennsylvania

Abstract

Based on a nationally representative sample of 8,099 Chinese drawn from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), this study investigated the long-term health consequences of early-life nutritional status, sibling sex-composition, childhood socioeconomic conditions, and place of birth on mortality at ages 80 and above between 1998 and 2005. Better nutritional status in childhood predicted lower mortality at ages 80 and above, net of childhood circumstances, adult socioeconomic status, and health behaviors. In addition, sibling sex composition had long-term health consequences, net of childhood and adult characteristics, such that women benefited from having grown up in families with only daughters, while men benefited from having grown up in families with both sons and daughters. Childhood socioeconomic status was only marginally related to old-age mortality and this association was attenuated further by the inclusion of adult characteristics. Place of birth was not a significant predictor of old-age mortality.

Keywords

mortality; oldest old; sibling composition; nutritional status; arm length; early life

Introduction

The supposition that health in adulthood has its antecedents in childhood is supported by evidence from a number of studies that have documented significant associations between early-life conditions and adult self-rated health (Laaksonen 2005; Haas 2007), chronic diseases (Elo and Preston 1992; Costa 1993; Blackwell et al. 2001), functional limitations (Luo and Waite 2005; Haas 2008), and mortality (Preston et al. 1998; Hayward and Gorman 2004; Kauhanen et al. 2006). Although much of the evidence to date is based on studies conducted in developed countries, similar associations have also been recorded in some less developed countries in Central and South America (Kohler and Soldo 2005; Palloni et al. 2006) and in China (Zeng et al. 2007). In this paper we report a study of associations among early-life nutritional status, sibling sex-composition, and childhood socioeconomic conditions on late-life mortality using the Chinese Longitudinal Healthy Longevity Survey (CLHLS). We were particularly interested in whether childhood nutritional status and sibling sex-composition had long-term health consequences in a society characterized by a strong preference for sons and high prevalence of infectious diseases and harsh economic conditions when study participants were growing up.

Cheng Huang is at the Hubert Department of Global Health, Rollins School of Public Health, Emory University, Grace Crum Rollins Building, 1518 Clifton Road, Atlanta, GA. 30322. chuan23@sph.emory.edu. Irma T. Elo is at the Population Studies Center, Department of Sociology, The University of Pennsylvania.

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The mechanisms through which early life conditions are held to influence adult health and mortality are both *direct*, including physiological 'scarring' (e.g., poor fetal environment, infectious diseases acquired in childhood) and acquired immunity, and *indirect*, operating through attained adult characteristics (e.g., socioeconomic status and lifestyle factors) and 'selection' whereby only exceptionally hardy individuals survive to old age (Power and Hertzman 1997; Preston et al. 1998). That ill health in childhood, perhaps as early as in utero (Barker 1995; Gluckman et al. 2008), has a direct positive association with poor health in adulthood is supported by findings from several recent studies (Kuh and Wadsworth 1993; Case et al. 2005; Kohler and Soldo 2005; Haas 2007; Zeng et al. 2007; Hass 2008). For example, utilizing data from the Health and Retirement Study (HRS) in the United States, Blackwell et al. (2001), documented a significant positive association between retrospectively reported childhood infectious diseases and an elevated risk of cardiovascular disease, cancer, lung disease, and arthritis/rheumatism, net of controls for childhood and adult socioeconomic status (SES). Further support for the association between childhood deprivation and infectious-disease load comes from studies that have used adult anthropometry as a proxy for dietary intake and infectious disease history. These studies have documented negative associations between adult morbidity and mortality and arm length (Kim et al. 2003; Jeong et al. 2005), height (Marmot et al. 1984; Waaler 1984; Notkola et al. 1985; Fogel and Costa 1997), and knee height (Palloni et al. 2006).

Other indicators of childhood environment, such as parents' SES, family composition, and rural or farm residence have also exhibited significant associations with adult health in previous studies (Notkola et al. 1985; Kuh and Wadsworth 1993; Preston et al. 1998; Hayward and Gorman 2004; Case et al. 2005; Kohler and Soldo 2005; Zeng et al. 2007). These associations are typically modified by adjustment for socioeconomic status and health behaviors in adulthood, providing support for the theory that childhood environment influences adult health indirectly via what Preston et al. (1998) refer to as 'correlated environments'. Children born into higher-SES households enter adulthood not only in better health, but also better educated (Case et al. 2002; Case et al. 2005) and likely to achieve higher SES in adulthood and thus have greater access to health-generating resources throughout their lives than individuals raised in less well-off families (Lynch et al. 1994; Duncan et al. 1998; Marmot and Wilkinson 2001; Elman and O'Rand 2004; Hayward and Gorman 2004; Smith 2005). At the same time, it appears that the associations between childhood and adult SES are not simply additive but interact in their influence on adult health outcomes with the result that higher adult SES may compensate for at least some of the negative consequences of disadvantaged childhood circumstances (Power et al. 1996; Luo and Waite 2005). Early life conditions have also been associated with health-related behaviors such as smoking, exercise, and diet (Lynch et al. 1997; van de Mheen et al. 1998; Furstenberg and Foley 1999) that are themselves associated with adult health and mortality (Hayward and Gorman 2004).

In this paper, we contribute to the literature by reporting the extension of previous analyses of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) and an examination of associations between childhood nutritional status, sibling sex-composition, early-life SES, place of birth, adult SES, health behaviors, and mortality at ages 80 and above. We proposed that early-life nutritional status, which captures both nutritional intake and the burden of infectious diseases in childhood (Martorell and Habicht 1986; Elo and Preston 1992), has a direct effect on old-age mortality owing to physiological 'scarring' (Preston et al. 1998). This proposition predicts a positive association between poor nutritional status and old-age mortality. In earlier work using the same data, Zeng et al. (2007) found that two retrospectively reported childhood health-related factors—receiving adequate medical services during childhood illness and never or rarely suffering from serious childhood illness—were associated with a significantly lower risk of physical-activity limitations, cognitive impairment, and self-reported poor health at ages 80 and above. These health outcomes, in turn, were highly significant predictors of mortality, controlling for a host of other childhood and adult characteristics. In this study, rather than relying on retrospectively reported childhood health conditions, we used arm length as an indicator of early-life nutritional status, which is considered a preferred anthropometric measure for studies of the elderly (Mitchell and Lischitz 1982; Kwok and Whitelaw 1991; Jarvis 1996; Brown et al. 2002).

We further proposed that family composition, measured by the sex-composition of the respondent's siblings, through its association with resource allocation within the household, had long-term health consequences. In China, where families have a strong preference for sons, resource allocations within the family have favoured boys over girls (Coale and Banister 1994; Choe et al. 1995; Das Gupta and Li 1999). In societies with a similar preference for sons, sibling sex-composition has been associated with child mortality in complex ways (Das Gupta 1987; Muhuri and Preston 1991; Arnold et al. 1998), yet little is known about its possible long-term health consequences. In addition to early-life nutritional status and sibling sex-composition, we included an indicator of childhood SES, measured by the father's occupation. Childhood SES has been associated not only with childhood health, but also with achieved social status in adulthood in previous studies. Our final measure of early-life conditions was urban versus rural place of birth. Until the early twentieth century, before urban public health campaigns and sanitary improvements, the disease environment was thought to have been worse in urban than in rural areas, with the situation reversing in subsequent decades (Campbell 1997; Zhang and Kanbur 2005). We also controlled for adult SES and health behaviors, which others have proposed as mediators of the influence of early-life experiences on adult health and mortality (Preston et al. 1998; Hayward and Gorman 2004).

We must also recognize the possible role of 'selection': the possibility that only biologically robust individuals survive from inferior environments to old age (Robert and House 1994; Preston et al. 1998). Hence, the early antecedents of old-age health disparities may not be observed or may be only weakly observed among the oldest old. Furthermore, twentieth-century China is a unique setting with its complex political history (Whyte 1975; Yao et al. 2004) and rapid mortality decline during the second half of that century (Salaff 1973; Caldwell 1986). Thus the specific 'pathways' through which early-life conditions influenced old-age mortality in China may differ from those observed in the West, on which most of the past evidence on associations between early-life conditions and adult health and mortality is based. For example, higher-SES backgrounds may not have conferred the same benefits in China as they did in the West because individuals from higher-SES backgrounds and those who had associated with the political regime before the Communist takeover in 1949 are likely to have suffered severe economic hardship in the early years of the Communist regime and during the Cultural Revolution between the late 1960s and the early 1970s (Zeng et al. 2007).

Data

The Chinese Longitudinal Healthy Longevity Survey (CLHLS) is the largest longitudinal study of individuals aged 80 and above ever undertaken with the goal of improving understanding of the determinants of human longevity (Zeng 2008). The baseline survey was conducted in 1998 in 631 randomly selected cities and counties in 22 Chinese provinces, and covered about 85 per cent of the total population in China. All centenarians in the selected sites were eligible to participate. Each participating centenarian was then matched with one octogenarian and one nonagenarian of pre-specified age and sex in nearby villages or districts, with the goal of randomly selecting similar numbers of men and women aged 80 to 99 (Zeng and Vaupel 2004). To adjust for sample selection, sampling weights were created according to the predicted age, sex, and residence distribution of the oldest old Chinese in 1998 (Zeng et al. 2001; Gu 2008). Follow-up interviews were conducted in 2000, 2002, and 2005. Information about deceased individuals was collected from a close family member of the deceased (Zeng and Vaupel 2004; Zeng 2008).

Interviews and basic health examinations were conducted in the respondent's home. The survey obtained detailed information about the following: family structure and marriage history; economic resources; living arrangements; fertility history and proximity of children; sibling information; psychosocial and socioeconomic characteristics, including early-life health and socioeconomic conditions; health behaviors; activities of daily living; functional limitations; self-rated health, cognitive function; and self-reported chronic conditions. Physiological measures, such as blood pressure and heart rate, were collected by trained medical personnel (Zeng and Vaupel 2004; Zeng 2008). Data quality in the CLHLS, except for self-reported chronic conditions, is considered to be good (Zeng et al. 2001, 2002; Gu and Zeng 2004; Gu 2008; Gu and Dupre 2008). In particular, age reporting, which is often a concern among the oldest old, has been shown to be accurate (Zeng et al. 2001; Gu and Zeng 2004).

In this study, we used data from the 1998 baseline survey and all three follow-up waves conducted in 2000, 2002, and 2005. Of the 8,959 respondents aged 80 and above in 1998, 1,010 were known to be alive in 2005 and 6,240 were known to have died between 1998 and 2005. All others were lost to follow-up at some time during the follow-up period. According to Zeng and Vaupel (2004) the most common reason for loss to follow up was an address change. Among those more likely to have been lost were women, individuals living in urban areas, those with physical and cognitive impairment, and those with low social ties (Gu 2007, 2008). When follow-up occurred, the individual was dropped from subsequent interviews. From our analytic sample we excluded the 860 individuals lost to follow-up between 1998 and 2000 and tested whether their exclusion influenced our results. We included the experience of the 572 participants lost to follow-up between 2000 and 2002 until 2000, and the experience of the 277 participants lost to follow-up between 2002 and 2005 until 2002 (Zeng and Vaulpel 2004; Gu et al. 2007; Zeng et al. 2007). Thus our analytic sample consisted of 8,099 respondents aged 80 and above in 1998, of whom 3,198 were men and 4,901 were women.

Explanatory variables

Information for all explanatory variables came from the 1998 baseline survey. Age was measured in single years. Ethnicity was coded as Han, the dominant ethnic group, versus all other ethnic groups combined.

Our measures of *early-life conditions* included respondent's arm length, the sex-composition of the respondents' siblings, father's occupation, and place of birth. Arm length, measured in centimeters, served as a proxy for nutritional status in childhood. It was measured as the out-stretched arm span from the uppermost point of the acromion to the end of processus styloideus ulnae, and the measurement was taken by a trained medical professional. We chose arm length over height because it is less subject to change with age (Mitchell and Lipschitz 1982; Kwok and Whitelaw 1991; Jarvis 1996; Brown et al. 2002). We measured the sex-composition of the children in the respondent's family of origin with a three-category variable coded as follows: single child (the respondent was the only child); multiple children of mixed sex-composition (the respondent had at least one sibling of the opposite sex); and multiple children of single sex (the respondent had one or more siblings who were of the same sex as the respondent).

We used father's occupation or industry of employment as an indicator of social origins and coded it as follows: agriculture, including employment in agriculture, forestry, animal husbandry, and fishing; professional/administrative occupations, including professional, technical, governmental, institutional, and managerial occupations; other non-agricultural employment, including employment in industrial, commercial, and military occupations; and housework/'other' ('other' refers to occupations not listed on the questionnaire but listed by the respondent; this response accounted for about 80 per cent of the occupations in this category). The professional/administrative sector represented the highest SES and housework/'other' the lowest. The measure of place of birth distinguished between urban and rural areas.

We also controlled for adult SES and health behaviors. In China, where educational opportunities were limited in the early twentieth century, educational attainment reflects both early-life opportunities and adult SES (Zeng et al. 2007). We coded education into two categories: those who received no schooling and those who had received at least one year of education (some schooling). We also included the participant's main occupation before age 60 and coded it similarly to the way used for father's occupation: agriculture; professional/administrative occupations; other non-agricultural employment; and housework/other. In addition we included a measure of financial support received by the respondent in 1998, which distinguished among the following: pension only, pension and other resources (other than family or government subsidy), family only, family and other resources (other than pension or government subsidy), government subsidies only, and other forms of support. In China, pension eligibility is limited to retired employees of government, state-owned enterprises, and some collective sectors. It provides a stable source of income and access to medical services at public expense. Government subsidies are separate and refer to support provided to disadvantaged individuals by the local government or community.

The health behaviors recorded were smoking, alcohol consumption, and regular physical exercise. For each behaviour, those who responded that they had never engaged in it were coded as 'never' and those who had done so in the past or were currently engaged in it were coded as 'ever'.

Methods and analytic strategy

We estimated Cox proportional hazard models with survival time measured in days from the date of the survey in 1998 to the recorded date of death or the date of the last interview (Cox 1972). The proportional hazard assumption was tested and confirmed (Grambsch and Therneau 1994;Allison 1995). We pooled men and women and tested for significant interactions between sex and childhood characteristics to examine possible differences in the associations between early-life conditions on old-age mortality among men and women. We applied multiple imputation (MI) to missing data on explanatory variables of interest (Little and Rubin 1989;Allison 2001). Results from models based on multiple imputations and those in which cases with missing values were excluded led to similar conclusions. We report results from models based on multiple imputation. We included sample weights that adjust for the non-random sample design available in the CLHLS in all regressions. Descriptive statistics shown in Table 1 are unweighted.

We estimated a series of nested models to examine the associations between early-life conditions and old-age mortality, an approach similar to that used in previous studies (Hayward and Gorman 2004; Zeng et al. 2007). In Model 1 we adjusted for age, sex, ethnicity, sibling sex-composition, place of birth, father's occupation, and arm length, including an interaction term between sibling sex-composition to account for its differential effects on old-age mortality between men and women. There were no other significant interactions between early-life conditions and respondents' sex. In Model 2, we added educational attainment, which captures both early childhood conditions and adult SES. In Model 3 we adjusted for adult SES (occupation and financial support) and in Model 4 we added health behaviors. Model 5 shows the results from our sensitivity analysis that examined whether the exclusion of individuals lost to follow-up between 1998 and 2000 biased our results. This analysis used inverse probability weights to adjust for loss to follow-up (see Appendix for further technical detail).

Results

Table 1 presents sample characteristics, including the distribution of missing data. Over 90 per cent of the respondents were Han Chinese; about 60 per cent were women with a sample mean age of 93 years. Early twentieth-century China was predominantly a rural, agricultural society. Over 85 per cent of the respondents were born in rural areas, and most were born to families in which fathers (about 73 per cent) worked in the agricultural sector. The vast majority of the respondents grew up in families with both sons and daughters. It was relatively rare to be the only child (8.6 per cent) or to grow up in families where all siblings were of the same sex (14.7 per cent). The mean arm length was about 49.6 centimeters with a standard deviation of 5.9. The mean arm length in our sample is somewhat shorter than that recorded for 1988 in an anthropometric study of a contemporary Chinese population, in which the mean arm length was 55.0 centimeters among men ages 18 to 60 and 49.7 centimeters among women ages 18 to 55 (Lin et al. 2004). These differences are to be expected given that these younger cohorts would have benefited from economic development and nutritional improvements that took place in China during the twentieth century (Morgan 2000).

Only about a third of the respondents had attended school. In early twentieth-century China, traditional education (*Sishu*) remained dominant and western type schooling was largely limited to coastal areas (Cao 1999;Hui 2005). Education was also more common in the upper classes. In our sample, over 50 per cent of respondents whose fathers worked in the nonagricultural sector had received some education, compared to less than 30 per cent of the respondents whose fathers were employed in agriculture or in housework and other occupations. Schooling was also more common among men than women (results not shown). Although most respondents had worked in the agricultural sector (57 per cent), a larger percentage (12 per cent of the males) was employed in professional/administrative occupations than had been the case in their fathers' generation. Close to 80 per cent of the respondents depended on the family for financial support with only about 15 per cent reporting that they received money from a pension. Less than five per cent of the sample relied solely on local government subsidies. The use of alcohol and cigarettes was relatively uncommon and less than a third of the respondents had engaged in regular physical exercise.

Childhood conditions and old-age mortality

The results of the multivariate analyses are presented in Table 2. Of the early-life conditions, sibling sex-composition and arm length are significant predictors of old-age mortality ($p \leq 0.05$) in Model 1. Not only do we find that men have a mortality hazard approximately 24 per cent higher than that of women, we also find a significant interaction between respondents' sex and their sibling sex-composition. The mortality hazard for men and women who are only children is about 20 per cent higher than that for men or women who grew up with siblings of opposite sex. Although the risk associated with being the only child is slightly lower for men than for women, the difference is not statistically significant. In contrast, men who grew up with only brothers experience a significantly higher risk of death than men who grew up with both brothers and sisters or women who grew up with only sisters. This excess risk is about 22 per cent for these men ($0.77*1.58 = 1.22$) when compared with men who had both brothers and sisters. It is even higher when compared with women who had only sisters. Women benefited most from growing up with only sisters as they experience the lowest risk of death at ages 80 and above. The inclusion of the number of siblings in the model does not change the above findings (result not shown), suggesting that the results are not confounded by the total number of siblings. The findings are also robust to the inclusion of respondents' educational attainment, adult occupation, sources of financial support, and health behaviors (Models 2–4, Table 2).

The results with respect to arm length are consistent with the hypothesis that early-life nutritional status has long-term health consequences. Arm length exhibits a significant negative association with mortality. Specifically, a log unit increase in arm length corresponds to a 22 percentage point decrease in the mortality hazard. Note that an equivalent absolute change in arm length (e.g., 5 cm) at the lower end of the arm-length distribution results in a greater decline in the hazard ratio than an equivalent absolute change at the higher end of this distribution. The inclusion of educational attainment and adult characteristics have little impact on the size of the estimated hazard ratio, although the level of significance is reduced in Models 2 and 4 (Table 2).

Childhood SES, measured by father's occupation, is a marginally significant predictor of old-age mortality and only in Model 1 (Table 2). Respondents whose fathers were employed in professional/administrative and non-agricultural occupations have a somewhat lower risk of death than those whose fathers were employed in agriculture. The coefficients for place of birth are insignificant in all models.

Adult characteristics, health behaviours, and old-age mortality

We also find that mortality at the oldest ages is associated with adult SES and health behaviors, adjusting for childhood characteristics. The mortality hazard of those who had attended any schooling is only about 84 per cent of that of respondents who had no schooling. Although this association is reduced slightly by the inclusion of occupation, financial support, (Model 3) and health behaviors (Model 4), it remains statistically significant.

Participants' occupation before age 60 and the source of financial support at baseline are also significant predictors of old-age mortality. Respondents who worked in professional or administrative occupations before age 60 experience significantly lower mortality than those who worked in the agricultural sector. The highest old-age mortality is documented for those who had been in housework or 'other' occupations. In addition, those who received financial support from both family and others and those who depended solely on pensions face a significantly lower mortality hazard than those who relied solely on the family for financial support. In contrast, individuals who reported that government was their sole source of financial support face a significantly higher risk of death. Because pension eligibility is tied to occupation, we tested whether the coefficients for occupation before age 60 and the sources of financial support in Model 3 were influenced by the inclusion of both variables in the same model. When the model was estimated with pension eligibility removed, the coefficients for occupation before age 60 were very similar to those shown in Model 3 in Table 2. Similarly, when occupation was removed, coefficients for financial support were comparable to those shown in Table 2. The inclusion of health behaviours (Model 4) has little effect on the results discussed above. Not surprisingly, current or former smokers experience excess old-age mortality compared to those who had never smoked (Model 4). Current or former alcohol consumption is not associated with old-age mortality, but those who currently engage or ever engaged in physical exercise face a significantly lower risk of death than those who had never engaged in this activity.

Selection bias due to loss to follow-up

As noted previously, we excluded respondents lost to follow up between 1998 and 2000. These individuals were more likely to be younger, be Han Chinese, be born in an urban area, have at least one year of schooling, work in the non-agricultural sector, be financially dependent on pension rather than on their families, ever to have engaged in physical exercise, and their fathers were more likely to have worked in the nonagricultural sector (results not shown). From the results reported above, we expected these individuals to have lower mortality than those included in our sample. The results of our sensitivity analysis designed to examine whether our conclusions are biased owing to the exclusion of respondents lost to follow up before 2000 are shown in Model 5, Table 2. A comparison of the coefficients obtained from Model 4 and

Model 5 show them to be nearly identical, suggesting that our conclusions are not affected by the exclusion of these respondents.

Discussion

Utilizing the CLHLS, this study has obtained new insights into the long-term health consequences of early-life conditions at the oldest ages. China, which was characterized by a high prevalence of infectious diseases and adverse economic conditions in the early twentieth century (Campbell 1997; Das-Gupta and Li 1999), provides a unique setting in which to examine the long-term consequences of early-life environment.

Our results for childhood nutritional status, measured by arm length, are consistent with the hypothesis that adverse childhood disease environment and poor nutritional status predict higher old-age mortality. This finding is consistent with previous research that has documented significant associations between adult health and various adult anthropometric measures used as proxies for diet and childhood disease environment (Waaler 1984; Elo and Preston 1992; Costa 1993; Fogel and Costa 1997; Kim et al. 2003; Jeong et al. 2005). It is also consistent with results reported by Zeng et al. (2007), who found that individuals who suffered from serious illness or did not receive adequate medical care when sick in childhood were at a greater risk of being in poor health at ages 80 and above than those who had not been sick or had received adequate medical care. Our finding is also consistent with evidence from several recent studies that have linked ill health in childhood with various adult health outcomes in developed countries (Blackwell et al. 2001; Luo and Waite 2005; Haas 2007, 2008;), and with results from Preston et al. (1998) who found that those African Americans who as children were exposed to the most unhealthy environments were least likely to live to age 85. Taken together these results suggest that improvements in childhood health conditions over the last several decades will contribute to better adult health and lower mortality over the next several years as cohorts exposed to more favorable childhood environments reach old age.

We have also documented significant associations between sibling sex-composition and old-age mortality. China is a society with a deep-seated preference for sons and a society in which resource allocations within families have favored sons over daughters (Campbell 1997; Das-Gupta and Li 1999). Studies of child mortality in countries with a similar preference for sons have documented higher child mortality for girls than for boys that is at least in part related to the sex-composition of the sibship and the birth order of the children, with girls who had at least one older sister experiencing elevated risk of child mortality (Muhuri and Preston 1991; Arnold et al. 1998). In contrast, we find that women who grew up in families with only sisters face the lowest risk of death at ages 80 and above. We speculate that this advantage at the oldest ages may stem at least in part from the fact that women who lived through childhood in these families subsequently did not have to compete with brothers for family resources such as food, care from parents, and family inheritance. However, it may also be that these women represent a particularly select group of robust survivors.

Our results also show that men who grew up with only brothers experienced a higher risk of death than men who grew up with both brothers and sisters. An adjustment for the number of siblings does not alter this finding. We speculate that in families with both sons and daughters, parents concentrated investments in sons; while in families with only sons, the sons had to compete for family resources.

We further find that men and women with no siblings faced a higher risk of death at ages 80 and above than their counterparts in families with both sons and daughters. In old China, where the belief ‘more offspring, more fortune’ (*duoziduofu*) prevailed, having only one child is less likely to have been due to the will of the parents than to other reasons such as illness or a death of a parent, which would have had negative long-term consequences for the respondent's well-being. Moreover, the higher mortality risk of the single child could also be related to the demands placed on him or her later in life. In China, only sons typically contributed financially to the natal household and care for older parents (Xu 2001). In contrast, daughters married at a young age (Tien 1983) and contributed little to their natal families thereafter (Whyte and Xu 2003). However, when a family had only a single daughter, the family was likely to find a man to *shangmen* (contract an uxorilocal marriage) for the daughter, with the daughter taking on the responsibilities of a son (Li et al. 2001).

We have also documented a modest association between father's occupation and old-age mortality. This association is attenuated with the inclusion of the respondent's education, adult SES, and health behaviors. These results are consistent with previous studies that have documented a mediating role of adult characteristics for the association between childhood SES and adult mortality (Hayward and Gorman 2004; Zeng et al. 2007). They also provide support for the notion of 'correlated environments'—the notion that childhood circumstances have an indirect effect on adult health operating through their association with adult SES and lifestyle (Preston et al. 1998).

On the other hand, respondents' education, which reflects both childhood circumstances and attained adult SES, retains a significant association with old-age mortality, a finding consistent with previous studies (Elo and Preston 1996; Zimmer and Kwong 2004; Smith 2005; Zhu and Xie 2007). Education had been held to influence health through numerous mechanisms, including access to material resources, adult health behaviors, personality traits, and cognitive abilities (Preston and Taubman 1994). It is, however, unclear what it is about education that matters in the present context. We speculate that education signals both an advantaged childhood background and access to resources throughout life that are not captured by our indicators of respondents' childhood environment, adult occupation, and health behaviors.

Although we believe our findings provide new insights into the association between childhood environment and old-age mortality, several limitations of our study mean we must be careful no to over-interpret our results. According to Gu and Dupre (2008) the 1998–2000 wave of CLHLS yielded estimates of mortality at ages 80–90 that were lower by 5 to 20 per cent than those based on the 2000 census of the Chinese population, and mortality was likely to be also underestimated thereafter. To the extent that this underestimation affects our results, we must be cautious in drawing conclusions. In addition, father's occupation, at best, only roughly captures variation in childhood SES among study participants. In old China, social stratification was primarily land-based, rather than occupation-specific (Moise 1977). In our sample, about 70 per cent of the fathers were employed in the agricultural sector, which included landless labourers, tenant farmers, farmers, and landlords, all of whom had very distinct socioeconomic positions in rural China.

Furthermore, we had to rely on retrospective reporting of the number and sex of the respondents' siblings. The reports may not have been accurate because respondents may have failed to report those siblings who died at a very early age. It would have been desirable to include the respondent's birth order, because previous research has shown that it is not only the number of brothers and sisters that matters for health but also one's birth order (Muhuri and Preston 1991). However, because information on birth order was missing for a large number of respondents, we chose not to include it. Nevertheless, our findings suggest sibling sex-composition has long-term health consequences, a finding that merits further investigation.

Our measures of adult SES may also be, at best, rough indicators of the adult life experiences of study participants, who were exposed to severe political and economic upheaval and at times to severe food shortages during their lives (Whyte 1975; Zhou and Hou 1999; Chen and Zhou

2007; Zeng et al. 2007). Our understanding of what role these experiences played in mortality at the oldest ages would have been enriched if we could have used longitudinal information about respondents' experiences during the political transition at mid-century, the Cultural Revolution, and thereafter. Finally, we should note that the statistical modeling employed in this paper did not account for selection or unobserved heterogeneity.

Although the unique experiences of the cohorts included in the analysis limit our ability to generalize our findings to other settings, our results are remarkably consistent with findings from previous studies for both developed and less developed country populations (Costa 1993; Blackwell et al. 2007; Haas 2007, 2008; Zeng et al. 2007). Thus our findings further reinforce the hypothesis that early-life environment has long-term health consequence and point to the need to employ a life-course perspective in the study of adult health and mortality (Power and Hertzman 1997; Hayward and Gorman 2004; Lynch and Davey Smith 2005). The study of the effects of early-life conditions is constrained by a lack of longitudinal data. Most studies to date have had to rely on retrospectively reported childhood health conditions and family background. Further research is needed to determine the reliability of these retrospective reports. Studies would also benefit from the use of ecological measures of childhood disease environment, which could be used to characterize the broader residential context. In addition, the biological mechanisms through which early-life health and nutritional status may influence adult health merits greater attention.

References

Allison, PD. Survival Analysis Using SAS: A Practical Guide. Cary, NC: Institute Press; 1995.

Allison, PD. Missing Data. Thousand Oaks, CA: Sage; 2001.

Arnold F, Choe MK, Roy TK. Son preference, the family-building process and child mortality in India. Population Studies 1998;52(3):301–315.

Barker DJ. Fetal origins of coronary heart disease. British Medical Journal 1995;311(6998):171–174. [PubMed: 7613432]

Blackwell DL, Hayward MD, Crimmins EM. Does childhood health affect chronic morbidity in later life? Social Science and Medicine 2001;52(8):1269–1284. [PubMed: 11281409]

Brown KJ, Feng J, Knapp TR. Is self-reported height or arm span a more accurate alternative measure of height? Clinical Nursing Research 2002;11(4):417–432. [PubMed: 12413114]

Case A, Fertig A, Paxson C. The lasting impact of childhood health and circumstance. Journal of Health Economics 2005;24(2):365–389. [PubMed: 15721050]

Case, Anne; Lubotsky, Darren; Paxson, Christina. Economic status and health in childhood: the origins of the gradient. American Economic Review 2002;92(5):1308–1334.

Caldwell JC. Routes to low mortality in poor countries. Population and Development Review 1986;12 (2):171–220.

Campbell C. Public health efforts in China before 1949 and their effects on mortality: the case of Beijing. Social Science History 1997;21(2):179–218.

Cao C. Social origins of the Chinese scientific elite. The China Quarterly 1999;160:992–1018. [PubMed: 20101808]

Chen Y, Zhou L. The long-term health and economic consequences of 1959–1961 famine in China. Journal of Health Economics 2007;26(4):659–681. [PubMed: 17289187]

Choe MK, Hao H, Wang F. The effects of gender, birth order, and other correlates on child survival in China. Social Biology 1995;42(1–2):50–64. [PubMed: 7481920]

Coale AJ, Banister J. Five decades of missing females in China. Demography 1994;31(3):459–479. [PubMed: 7828766]

Costa LD. Height, weight, wartime stress, and older age mortality: evidence from the union army records. Explorations in Economic History 1993;30(4):424–449.

Cox DR. Regression models and life tables (with discussion). Journal of the Royal Statistical Society B 1972;34(2):187–220.

Das Gupta M. Selective discrimination against female children in rural Pubjab, India. Population and Development Review 1987;13(1):77–100.

Das Gupta M, Li S. Gender bias in China, South Korea and India 1920–1990: the effects of war, famine, and fertility decline. Development and Change 1999;30(3):619–652. [PubMed: 20175302]

Duncan GJ, Yeung WJ, Brooks-Gunn J, Smith JR. How much does childhood poverty affect the life chances of children? American Sociological Review 1998;63(3):406–423.

Elman C, O'Rand AM. The race is to the swift: socioeconomic origins, adult education, and wage attainment. American Journal of Sociology 2004;110(1):123–160.

Elo IT, Preston SH. Effects of early-life conditions on adult mortality: a review. Population Index 1992;58 (2):186–212. [PubMed: 12285320]

Elo IT, Preston SH. Educational differentials in mortality: United States, 1979–1985. Social Science and Medicine 1996;42(1):47–57. [PubMed: 8745107]

Fogel RW, Costa DL. A theory of technophysio evolution, with some implications for forecasting population, health care costs, and pension costs. Demography 1997;34(1):49–66. [PubMed: 9074831]

Furstenberg, F.; Foley, K. Paternal Involvement and Children's Health: A Longitudinal Study. Presentation paper, Urban Seminar on Fatherhood; Harvard University; 1999.

Gluckman DP, Hanson MA, Cooper C, Thornburg KL. Effect of in utero and early-life conditions on adult health and disease. The New England Journal of Medicine 2008;359(1):61–73. [PubMed: 18596274]

Grambsch PM, Therneau TM. Proportional hazards tests and diagnostics based on weighted residuals. Biometrika 1994;81(3):515–526.

Gu, D. General data quality assessment for the 2005 CLHLS wave. CHHLS Technical Report No. 2007-1. 2007. http://www.geri.duke.edu/china_study/

Gu, D. General data quality assessment of the CLHLS. In: Zeng, Y.; Poston, D.; Vlosky, DA.; Gu, D., editors. Health longevity in China: Demographic, socioeconomic, and psychological dimensions. Dordrecht, The Netherlands: Springer Publisher; 2008. p. 39-60.

Gu, D.; Dupre, ME. Assessment of reliability of mortality and morbidity in the 1998–2002 CLHLS waves. In: Zeng, Y.; Poston, D.; Vlosky, DA.; Gu, D., editors. Health longevity in China: Demographic, socioeconomic, and psychological dimensions. Dordrecht, The Netherlands: Springer Publisher; 2008. p. 99-116.

Gu D, Dupre ME, Liu G. Characteristics of the institutionalized and community- residing oldest-old in China. Social Science and Medicine 2007;64(4):871–883. [PubMed: 17126971]

Gu D, Zeng Y. Sociodemographic effects on the onset and recovery of ADL disability among Chinese oldest-old. Demographic Research 2004;11(1):1–42.

Haas AS. The long-term effects of poor childhood health: an assessment and application of retrospective reports. Demography 2007;44(1):113–135. [PubMed: 17461339]

Haas AS. Trajectories of functional health: the "long arm" of childhood health and socioeconomic factors. Social Science and Medicine 2008;66(4):849–861. [PubMed: 18158208]

Hayward MD, Gorman BK. The long arm of childhood: the influence of early-life social conditions on men's mortality. Demography 2004;41(1):87–107. [PubMed: 15074126]

Hogan WJ, Roy J, Korkontzelou C. Handling drop-out in longitudinal studies. Statistics in Medicine 2004;23(9):1455–1497. [PubMed: 15116353]

Hui L. Chinese cultural schema of education: implications for communication between Chinese students and Australian educators. Issues in Educational Research 2005;15(1):17–36.

Jarvis, C. Physical Examination and Health Assessment. 2. Philadelphia: W.B. Saunders; 1996.

Jeong S, Kim J, Kweon S, Shin M, Seo M, Kim Y. Does arm length indicate cognitive and functional reserve. International Journal of Geriatric Psychiatry 2005;20(5):406–412. [PubMed: 15852453]

Kauhanen L, Lakka HM, Lynch JW, Kauhanen J. Social disadvantages in childhood and risk of all-cause death and cardiovascular disease in later life: a comparison of historical and retrospective childhood information. International Journal of Epidemiology 2006;35(4):962–968. [PubMed: 16556645]

Kim JM, Stewart R, Shin IS, Yoon JS. Limb length and dementia in an older Korean population. Journal of Neurology, Neurosurgery and Psychiatry 2003;74(4):427–432.

Kohler IV, Soldo BJ. Childhood predictors of late-life Diabetes: The case of Mexico. Social Biology 2005;52(3–4):113–131.

Kuh D, Wadsworth MEJ. Physical health status at 36 years in a British national birth cohort. Social Science & Medicine 1993;37(7):905–916. [PubMed: 8211309]

Kwok T, Whitelaw MN. The use of armspan in nutritional assessment of the elderly. Journal of American Geriatrics Society 1991;39(5):492–496.

Laaksonen M, Rahkonen O, Martikainen P, Lahelma E. Socioeconomic position and self-rated health: the contribution of childhood socioeconomic circumstances, adult socioeconomic status, and material resources. American Journal of Public Health 2005;95(8):1403–1409. [PubMed: 16006419]

Li S, Feldman MW, Li N. A comparative study of determinants of uxorilocal marriage in two counties of China. Social Biology 2001;48(1–2):125–150. [PubMed: 12194444]

Lin Y, Wang MJ, Wang EM. The comparisons of anthropometric characteristics among four peoples in East Asia. Applied Ergonomics 2004;35(2):173–178. [PubMed: 15105079]

Little R, Rubin DB. The analysis of social science data with missing values. Sociological Methods & Research 1989;18(2):292–326.

Luo Y, Waite L. The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. Journal of Gerontology Series B: Psychological Science and Social Science 2005;60 (2):S93–S101.

Lynch JW, Kaplan GA, Cohen RD, Kauhanen J, Wilson TW, Smith NL, Salonen JT. Childhood and adult socioeconomic status as predictors of mortality in Finland. Lancet 1994;343(8896):524–527. [PubMed: 7906766]

Lynch JW, Kaplan GA, Salonen JT. Why do poor people behave poorly? Variation in adult health behaviors and psychosocial characteristics by stages of the socioeconomic lifecourse. Social Science and Medicine 1997;44(6):809–819. [PubMed: 9080564]

Lynch JW, Davey Smith G. A life course approach to chronic diseases epidemiology. Annual Review of Public Health 2005;26:1–35.

Marmot M, Wilkinson RG. Psychosocial and material pathways in the relation between income and health: a response to Lynch et al. British Medical Journal 2001;322(7296):1233–1236. [PubMed: 11358781]

Marmot MG, Shipley MJ, Rose G. Inequalities in death: specific explanations of a general pattern. Lancet 1984;1(8384):1003–1006. [PubMed: 6143919]

Martorell, R.; Habicht, JP. Growth in early childhood in developing countries. In: Falkner, F.; Tanner, JM., editors. Human Growth: A Comprehensive Treatise. Vol. 3. New York: Plenum Press; 1986. p. 241-262.

Mitchell CO, Lipschitz DA. Arm length measurement as an alternative to height in nutritional assessment of the elderly. Journal of Parenteral and Enteral Nutrition 1982;6(3):226–229. [PubMed: 7202060]

Morgan SL. Richer and taller: stature and living standards in China, 1979–1995. The China Journal 2000;44(5):1–39. [PubMed: 18411497]

Moise E. Downward social mobility in pre-revolutionary China. Modern China 1977;3(1):3–31.

Muhuri PK, Preston SH. Effects of family composition on mortality differentials by sex among children in Matlab, Bangladesh. Population and Development Review 1991;17(3):415–434.

Notkola V, Punsar S, Karvonen MJ, Haapakaski J. Socioeconomic conditions in childhood and mortality and morbidity caused by coronary heart disease in adulthood in rural Finland. Social Science & Medicine 1985;21(5):517–523. [PubMed: 4049020]

Palloni A, McEniry M, Wong R, Pelaez M. The tide to come: elderly health in Latin America and the Caribbean. Journal of Aging and Health 2006;18(2):180–206. [PubMed: 16614340]

Power C, Hertzman C. Social and biological pathways linking early life and adult disease. British Medical Bulletin 1997;53(1):210–221. [PubMed: 9158295]

Power C, Matthews S, Manor O. Inequalities in self rated health in the 1958 birth cohort: lifetime social circumstances or social mobility? British Medical Journal 1996;313(7055):449–453. [PubMed: 8776310]

Preston SH, Hill ME, Drevenstedt GL. Childhood conditions that predict survival to advanced ages among African-Americans. Social Science and Medicine 1998;47(9):1231–1246. [PubMed: 9783866]

Preston, SH.; Taubman, P. Socioeconomic differences in adult mortality and health status. In: Martin, LG.; Preston, H., editors. Demography of Aging. Washington, D.C: National Academy Press; 1994. p. 279-318.

Robert, S.; House, J. SES and health over the life course. In: Abeles, RP.; Gift, HC.; Ory, MG., editors. Aging and Quality of Life. New York: Springer Publishing Company; 1994. p. 253-274.

Salaff WJ. Mortality decline in the people's republic of China and the United States. Population Studies 1973;27(3):551–576.

Smith JP. Unraveling the SES-health connection in aging, health, and public policy: demographic and economic perspectives, a supplement to. Population and Development Review 2005;30:108–132.

Tien HY. Age at marriage in the people's republic of China. The China Quarterly 1983 Mar;93:90–107.

van de Mheen H, Stronks K, Looman CW, Mackenbach JP. Does childhood socioeconomic status influence adult health through behavioral factors? International Journal of Epidemiology 1998;27 (3):431–437. [PubMed: 9698131]

Waaler HT. Height, weight and mortality: the Norwegian experiment. Acta Medica Scandinavica 1984;679(Suppl):1–56. [PubMed: 6585126]

Whyte MK. Inequality and stratification in China. The China Quarterly 1975 Dec;64:684–711.

Whyte, M.; Xu, Q. Support for aging parents from daughters versus sons. In: Whyte, M., editor. China's Revolutions and Intergenerational Relations. MI: Center of Chinese Studies, the University of Michigan; 2003. p. 167-196.

Xu Y. Family support for old people in rural China. Social Policy & Administration 2001;35(3):307–320.

Yao S, Zhang Z, Hanmer L. Growing inequality and poverty in China. China Economic Review 2004;15 (2):145–163.

Zeng, Y. Introduction to the Chinese Longitudinal Healthy Longevity Survey (CLHLS). In: Zeng, Y.; Poston, D.; Vlosky, DA.; Gu, D., editors. Health longevity in China: Demographic, socioeconomic, and psychological dimensions. Dordrecht, The Netherlands: Springer Publisher; 2008. p. 23-38.

Zeng Y, Gu D, Land KC. The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. Demography 2007;44(3):497–518. [PubMed: 17913008]

Zeng Y, Vaupel JW, Zhengyu X, Zhang C, Liu Y. The healthy longevity survey and the active life expectancy of the oldest old in China. Population: An English Selection 2001;13(1):95–116.

Zeng Y, Vaupel JW, Zhengyu X, Zhang C, Liu Y. Sociodemographic and health profiles of the oldest old in China. Population and Development Review 2002;28(2):251–273.

Zeng Y, Vaupel JW. Association of late childbearing with healthy longevity among the oldest-old in China. Population Studies 2004;58(1):37–53. [PubMed: 15204261]

Zhang X, Kanbur R. Spatial inequality in education and health care in China. China Economic Review 2005;16(2):189–204.

Zhou X, Hou L. Children of the cultural revolution: the state and the life course in the People's Republic of China. American Sociological Review 1999;64(1):12–36.

Zhu H, Xie Y. Socioeconomic differentials in mortality among the oldest old in China. Research on Aging 2007;29(2):125–143.

Zimmer Z, Kwong J. Socioeconomic status and health among older adults in rural and urban China. Journal of Aging and Health 2004;16(1):44–70. [PubMed: 14979310]

APPENDIX

We used an inverse probability-weighted estimator to investigate whether the exclusion of respondents lost to follow-up was likely to bias our findings. This technique is based on the idea that each individual has some probability (ρ_i) of being followed up and an inverse of this probability ($w_i = 1/\rho_i$) can be used to weight the sample to account for cases that were lost to follow-up. We followed the tutorial by Hogan et al. (2004) to implement this procedure. We first estimated a logistic regression model predicting the probability of being followed-up in the 2000 CLHLS survey wave, using as covariates all explanatory variables included in our analysis plus the province in which the respondent resided in 1998. We then assigned all respondents included in our analytic sample a weight that was equal to the inverse of the predicted probability based on the logistic regression model. The theory behind this weighting scheme is that respondents included in the analysis represent not only themselves but also those similar in their baseline characteristics in 1998 but lost to follow-up between 1998 and 2000.

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Table 1

Characteristics of the oldest old Chinese in the 1998 baseline survey[1]

Explanatory variable	Total (N= 8,099)	Died 1998–2005 (N=6,240)	Alive[2] (N=1,859)
Demographic characteristics			
Age *(Std. Dev.)*	92.6 (7.6)	94.0 (7.3)	87.8 (6.7)
Sex			
Male	39.5	39.0	41.2
Female	60.5	61.0	58.8
Ethnicity			
Han	92.2	92.0	92.9
Other	7.6	7.8	6.9
Missing	0.2	0.1	0.2
Early-life conditions			
Siblings			
Multiple children, mixed sex	68.6	67.5	72.2
Multiple children, single sex	14.7	14.9	14.3
Single child	8.6	8.8	8.0
Missing	8.0	8.8	5.5
Place of birth			
Rural	86.3	87.7	81.6
Urban	13.7	12.2	18.4
Missing	0.0	0.0	0.0
Father’s occupation			
Agricultural[3]	72.8	74.3	68.0
Professional/administrative	4.4	3.8	6.5
Other non- agricultural[4]	15.5	14.3	19.6
Housework and Other[5]	6.7	7.1	5.4
Missing	0.5	0.6	0.4
Arm length (Std. Dev.)[6]	49.6 (5.9)	49.5 (5.9)	49.8 (5.8)
Missing %	3.8	3.3	5.3
Adult characteristics			
Education			
No schooling	68.3	70.6	60.5
1+ years of schooling	31.2	28.8	39.1
Missing	0.5	0.6	0.4
Occupation before age 60			
Agricultural[3]	57.0	59.4	49.1
Professional/administrative	6.1	4.6	10.9
Other non-agricultural[4]	16.1	15.0	20.0
Housework and Other[5]	20.8	21.0	20.0
Missing	0.1	0.1	0.1

Explanatory variable	Total (N= 8,099)	Died 1998–2005 (N=6,240)	Alive[2] (N=1,859)
Financial support			
Family only	62.0	64.1	55.3
Family and others	17.5	18.3	14.9
Pension only	5.4	4.1	9.6
Pension and other	9.4	7.9	14.6
Government only	3.9	4.0	3.3
Other[7]	1.7	1.6	2.3
Missing	0.0	0.1	0.0
Health behaviors			
Alcohol consumption			
Never	66.7	66.3	68.1
Ever	33.1	33.5	31.6
Missing	0.3	0.3	0.3
Smoking			
Never	68.5	69.1	66.4
Ever	31.3	30.7	33.3
Missing	0.2	0.2	0.3
Exercise			
Never	71.9	74.8	62.0
Ever	27.9	24.9	37.8
Missing	0.3	0.3	0.3

[1] This table is based on un-weighted data.

[2] Includes 1,010 respondents known to be alive in 2005 and those (849) known to be alive in 2000 but lost to follow-up after 2000;

[3] Agriculture, forestry, animal husbandry, and fishery;

[4] Industrial worker, commercial or service worker, and military personnel;

[5] Not specified in the questionnaire.

[6] Among those who have no missing value on arm length;

[7] Work or other resources not specified.

Source: Chinese Longitudinal Healthy Longevity Survey (CLHLS)

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Table 2

Estimated hazard ratios of mortality among the oldest old in China between 1998 and 2005. Cox proportional hazards models, based on multiple imputation (N=8,099)

Explanatory variables	Model 1	Model 2	Model 3	Model 4	Model 5
Demographic characteristics					
Male	1.24**	1.35**	1.45**	1.40**	1.41**
Age	1.08**	1.08**	1.08**	1.08**	1.08**
Ethnicity (Han)					
Other	1.11*	1.09	1.07	1.04	1.02
Early-life conditions					
Siblings (multiple children, mixed sex)					
Single child	1.23**	1.24**	1.18*	1.18*	1.19**
Multiple children, single sex	0.77**	0.77**	0.76**	0.76**	0.77**
*Male*single child*	0.92	0.91	0.93	0.94	0.94
*Male*single sex*	1.58**	1.55**	1.52**	1.52**	1.50**
Place of birth (Rural)					
Urban	0.94	0.97	1.00	1.02	1.03
Father's occupation (Agricultural)[1]					
Professional/administrative	0.90†	0.95	1.02	1.02	1.02
Other non-agricultural[2]	0.93†	0.95	0.96	0.96	0.97
Housework & other[3]	1.01	1.01	0.98	0.98	0.98
Logged Arm Length (cm)	0.78*	0.78†	0.76*	0.79†	0.82
Adult characteristics					
Education (no schooling)					
1+ year schooling		0.84*	0.87**	0.90**	0.90**
Occupation before age 60 (Agricultural)[1]					
Professional/administrative			0.78**	0.83*	0.82**
Other non-agricultural[2]			1.02	1.05	1.02
Housework and Other[3]			1.11*	1.11*	1.11*

Explanatory variables	Model 1	Model 2	Model 3	Model 4	Model 5
Financial support (Family only)					
Family and others			0.75**	0.74**	0.74**
Pension only			0.79**	0.81**	0.82**
Pension and other			0.93	0.96	0.96
Government only			1.26**	1.28**	1.27**
Other[4]			0.89	0.89	0.89
Health behaviors					
Alcohol consumption (Never)					
Ever				0.98	0.98
Smoking (Never)					
Ever				1.11**	1.12**
Exercise (Never)					
Ever				0.74**	0.74**
Model fit statistics (−2 Log L)					
Without covariates	76236.7	---	---	---	---
With covariates	75774.7	75751.8	75660.0	75581.1	---

† p<0.1

* p<0.05

** p<0.01; results are based on weighted sample; the omitted category is in parentheses.

[1] Agriculture, forestry, animal husbandry, and fishery;

[2] Industrial worker, commercial or service worker, military personnel;

[3] Not specified in the questionnaire;

[4] Work or other resources not specified.

Source: As for Table 1.