Published in final edited form as:

Soc Sci Med. 2014 October ; 119: 207–214. doi:10.1016/j.socscimed.2014.07.003.

Direct and Indirect Effects of Childhood Conditions on Survival and Health among Male and Female Elderly in China

K Shen[1] and **Y Zeng**[2]

[1]Institute of Population Research, School of Social Development and Public Policy, Fudan University, Shanghai, 200433, China. shenke@fudan.edu.cn

[2]Center for the Study of Aging and Human Development and Geriatric Division of Medical School, Duke University, Durham, NC 27710, USA; Center for Healthy Aging and Development Studies, National School of Development, Peking University, Beijing, 100871, China

Abstract

This paper investigates whether childhood conditions affect survival and health, both directly and indirectly through the mediating variable of adulthood socioeconomic status, among Chinese elderly. Using data from the 2008–2009 and 2011–2012 waves of the Chinese Longitudinal Healthy Longevity Survey, we apply structural equation models to estimate these effects. We find that favorable childhood conditions exert a negative direct impact on survival probability at senior ages, possibly resulting from mortality selection. Our results also support the pathways model, which indicates that advantageous childhood conditions improve socioeconomic status in adulthood and thus indirectly promote longevity and health at advanced ages. Combining the direct and indirect effects, the total effects of childhood advantages on survival and health are positive. We further demonstrate that direct and indirect effects of childhood conditions are stronger for women than they are for men. Our findings suggest that public policies that target childhood wellbeing may have far-reaching protective impacts on health among seniors.

Keywords

China; childhood conditions; socioeconomic status; health; structural equation model

Introduction

Socioeconomic disparities in morbidity and mortality have long been an important topic in inequality research, especially in rapidly developing economies with growing income inequality. Recent studies in the life course context have expanded to investigate linkages between childhood conditions and a range of health outcomes among the elderly. For example, children born into impoverished families tend to experience increased morbidity, disability, and mortality when they are older adults (Bengtsson & Brostrom, 2009; Elo & Preston, 1992; Galobardes, Lynch, & Smith, 2008; Hayward & Gorman, 2004; Huang & Elo, 2009; O'Rand & Hamil-Luker, 2005). However, there are disputes on how early-life circumstances persist to affect late-life health and longevity.

Three hypotheses attempt to answer this question. The *fetal origins hypothesis* affirms the positive direct effect of advantageous childhood conditions on health at old ages. It argues that certain adversities and diseases acquired in childhood may permanently impair survivors and thus increase death rates at subsequent ages (Barker, Osmond, Winter, Margetts, & Simmonds, 1989; Gluckman, Hanson, Cooper, & Thornburg, 2008). Ozanne and Hales' (2004) experimental work on mice has confirmed that mice with restricted fetal growth who were well fed after birth exhibited rapid catch-up growth, but they died significantly earlier than did mice who were well fed in utero. Empirical studies on human populations have supported this finding. For example, low birth weight or growth retardation in childhood elevated the risk of death from chronic diseases, especially cardiovascular diseases and diabetes, in later ages (Barker & Martyn, 1992).

In contrast with the fetal origins hypothesis, the *mortality selection* hypothesis suggests a direct and inverse association between advantages in early life and good health in late life. Specifically, an individual who survives harsh and poor environments in childhood has genetic or congenital traits that enhance survival and health across the life cycle (Preston, Hill, & Drevenstedt, 1998). For instance, Mu and Zhang (2011) compared health outcomes in adulthood between famine survivors who were born during China's Great Famine (1959–1961) and a control cohort who were born after the famine (1963–1965). They found that male famine survivors, who experienced extreme adversities in childhood, were much less likely to be disabled in 1990, compared to the male control cohort, who did not experience similar childhood adversities.

The third hypothesis is the *pathways model*, which indicates that the impact of early-life circumstances on late-life health is mostly indirect through the mediator of adulthood socioeconomic status (SES). In other words, childhood circumstances set individuals on diverse social and economic trajectories in adulthood that, in turn, affect their health at old ages (Marmot, Brunner, & Hemingway, 2001). For instance, Hayward and Gorman (2004) and Zeng, Gu, and Land (2007) found that the associations between childhood conditions and mortality risk at old ages were substantially attenuated or even disappeared when adulthood factors were incorporated into the models in the United States and China, respectively. In a study of New England residents, Turner and Butler (2003) applied path analyses and showed that most of the association between childhood adversities and late-life depression was mediated by adulthood adversities. Using a Finnish sample, Laaksonen et al. (2007) applied structural equation modeling to find that childhood circumstances were not directly associated with physical or mental functioning, but they found indirect effects resulting through adult SES.

In addition to exploring the impacts of childhood circumstances on late-life health among the general population, researchers have further documented gender differences in the contributions of early-life circumstances, but findings have been inconsistent. For example, Hamil-Luker and O'Rand (2007) found that women who grew up without a father and under adverse economic conditions were more likely to experience elevated heart attack risk in adulthood, while childhood SES had no impact on heart attack risk among men. Using a nationally representative cohort born in March 1945 in Great Britain, Kuh, Hardy, Langenberg, Richards, and Wadsworth (2002) also found that childhood SES more strongly predicted adult mortality among women than among men. However, Zeng et al. (2007) showed that a father's occupation in childhood played a more important role in predicting mortality among male oldest-old aged over 80, compared to female counterparts.

Our study contributes to this growing body of knowledge about the link between childhood circumstances and elderly survival and health in several ways. First, we quantify the magnitude of direct, indirect, and total effects of childhood conditions on survival and health among the elderly using structural equation models (SEMs). This task cannot be achieved with the conventional regression methods used in previous research (Hayward & Gorman, 2004; Zeng et al., 2007). Second, we pay special attention to gender differences in the contributions of childhood conditions. Hayward and Gorman (2004) restricted their sample to older men in the United States, and Preston et al. (1998) included gender only as a control variable in their estimation. Third, we sample from an elderly population in China, whereas previous studies have targeted developed countries (Hayward & Gorman, 2004; Laaksonen et al., 2007). The contributions of early-life conditions in developed countries might differ from developing countries, where social inequalities of origin are more serious and recent economic transformations are more radical. A notable exception is the study by Zeng et al. (2007), which investigated data from 1998–2002 for the oldest-old (i.e., aged above 80) in China, but it excluded the young-old (i.e., aged between 65 and 79).

The paper is organized as follows. Section 2 describes the data, estimation method, and measurement. Section 3 presents the direct, indirect, and total effects of childhood conditions on survival and health by using full samples and male and female sub-samples. Section 4 discusses the results and concludes the paper.

Data, Method, and Measurement

Data source

Our study uses data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which is the largest longitudinal survey of centenarians, nonagenarians, and octogenarians ever conducted. The CLHLS randomly selected half of the counties in 22 out of 31 Chinese provinces, whose populations together constitute about 85% of the total population in China. The CLHLS was conducted in 1998, 2000, 2002, 2005, 2008–2009 (late 2008 and early 2009), and 2011–2012 (late 2011 and early 2012). The 1998 and 2000 waves targeted the oldest-old (i.e., aged above 80). The young-old group (i.e., aged between 65 and 79) was added since the 2002 wave. These surveys provide rich information on retrospective history in childhood and adulthood, as well as current health of the elderly.

This paper is based on the panel data from the latest 2008–2009 and 2011–2012 waves of the CLHLS. Excluding those who were lost to follow-up in the 2011–2012 wave, the longitudinal data includes 12,258 elderly aged above 65 who were interviewed in 2008–2009. Of those, 7,341 elderly survived until the 2011–2012 survey, and 4,917 elderly died before the follow-up. Table 1 presents the 2008–2009 sample distribution by gender and age groups. Extensive evaluations, including assessments of non-response rate, sample attrition, reliability and validity of health measures, and the rates of logically inconsistent answers have shown that data quality is acceptably good, compared to other surveys of the elderly (Chen, 2010; Shen, 2010).

Method

We apply the structural equation model (SEM) in our study. As previously noted, a complex relationship exists between childhood conditions and survival and health at advanced ages. For example, childhood conditions may influence late-life health, both directly and indirectly through the mediator of adulthood SES. Consequently, adulthood SES is the dependent variable in one set of relationships and an explanatory variable of late-life health. Unlike conventional regression methods, an SEM enables us to deal with such complex relationships and to estimate the direct and indirect effects of the variables of interest.

In addition, traditional multivariate regressions are based on observed measurements only, whereas SEM incorporates both unobserved (i.e., latent) variables, which are represented by circles in Figure 1, and their observed indicators, which are represented by boxes (Byrne, 1998). In this study, constructs such as childhood conditions, adulthood SES, and health cannot be observed directly and are thus operationally measured by several observed indicators. SEM comprises both a measurement model and a structural model. The measurement model depicts the linkages between latent variables and their observed measures (denoted as $\lambda_1 \ldots \lambda_4$, $\gamma_1 \ldots \gamma_s$), and the structural model depicts the links among latent variables themselves (denoted as $a, b \ldots f, g$).

As shown in Figure 1, we construct a hypothesized conceptual model. We quantitatively estimate “a”, which is the direct effect of childhood conditions on adulthood SES; “b”, which is the direct effect of adulthood SES on current health; and “c”, which is the direct effect of childhood conditions on current health. Following the statistical methodology in previous studies (Ames, Sussman, Dent, & Stacy, 2005; Bollen, 1987; Mi, Eskridge, George, & Wang, 2011; Sobel, 1987), we estimate the indirect effect of childhood conditions on health through the mediator of adulthood SES by multiplying “a” and “b”. The total effect is obtained by summing the direct and indirect effects ($c + a \times b$). Age and gender are adjusted for by allowing them to correlate with all dependent latent variables. Goodness of fit of the models is assessed using the comparative-fit index, goodness-of-fit index, and root mean square error of approximation. A comparative-fit index and goodness-of-fit index greater than 0.90 and a root mean square error of approximation less than 0.08 indicate a good fit to the data (Byrne, 1998). Models are estimated with LISREL (version 8.80) using weighted least square estimation procedures.

Measurements

SEM in our study includes three latent variables: current health outcome (dependent latent variable), adulthood SES (both dependent and explanatory latent variable), and childhood conditions (explanatory latent variable). Each latent variable is captured by several observed indicators. Table 2 presents the summary statistics for key indicators. The 2008–2009 survey measured all indicators of childhood conditions and adulthood SES, and the 2011–2012 survey measured indicators of health outcomes.

Current health outcome is first captured by the survival probability. CLHLS longitudinal data provides mortality information of the respondents in the 2011–2012 follow-up, allowing us to estimate the impacts of early-life conditions on survival probability among Chinese elderly from the 2008–2009 to the 2011–2012 waves.

For the 7,341 elderly who survived until the 2011–2012 survey, we measure current health outcome using four indicators: the respondent's instrumental activities of daily living (IADL), Mini-Mental State Examination (MMSE), chronic diseases, and self-rated health (SRH) at the 2011–2012 wave.

IADL assesses the ability to perform daily tasks and comprises eight activities: visit the neighbors, go shopping, cook a meal, wash clothes, walk continuously for 1 kilometer, lift a weight of 5 kilogram, continuously crouch and stand up three times, and take public transportation. Respondents who can finish eight activities without assistance are regarded as IADL independent; respondents who need assistance to finish at least one of these activities are regarded as IADL dependent. Previous studies have confirmed that disabilities in at least one IADL item can identify elderly persons who are in apparent good health but are at increased risk of frailty or dementia (Barberger-Gateau, Fabrigoule, Helmer, Rouch, & Dartigues, 1999; Nourhashémi et al., 2001).

MMSE has long been used as a screening instrument for the detection of cognitive impairment (Gagnon et al., 1990). The CLHLS uses a culturally adapted, Chinese version of MMSE, which is based on the international standard MMSE questionnaire (Folstein, Folstein, & McHugh, 1975) and carefully tested in pilot survey interviews. The Chinese MMSE includes five dimensions: orientation capacity, reaction, calculation ability, recall, and language ability. MMSE scores range from 0 to 30. Scores of 24 and above indicate normal cognitive function, and scored below 24 indicate impaired cognition.

Chronic diseases have been major health concerns and primary causes for death in recent decades. Chronic diseases in our measurement include diabetes, hypertension, and cardiovascular diseases, such as heart attack and stroke. Respondents with any of these diseases are regarded as having chronic diseases.

SRH is a subjective health measure that has been demonstrated as a strong predictor of mortality among the elderly, independent of various objective health measures (Grant, Piotrowski, & Chappell, 1995; Mossey & Shapiro, 1982). The CLHLS measures SRH by using the question, "How do you rate your health at present?" Five response alternatives range from "very good to "very bad". We combine the first two responses into one category (i.e., good SRH) and the latter three into one category (i.e., poor SRH).

Childhood conditions are captured by four observed dichotomous indicators. We choose these variables because of their potential associations with survival and health (Preston et al., 1998; Zeng et al., 2007). The first indicator is birthplace, which is categorized as urban or rural. CLHLS interviewees were born in the early half of 20th century, when industrialization and modernization promoted urban development and urban-rural disparities increased. For instance, 147 out of 193 cities in the 1930s were located in coastal regions with vibrant and developed economies (Shen, 1937). Thus, birthplace serves as a proxy of the local economic environment during childhood.

The second and third indicators are the father's education (1 = at least one year of schooling; 0 = illiterate) and the father's occupation in childhood (1 = non-manual worker, such as professional, government official, and military officer; 0 = manual worker, such as farmer, forester, and fisherman). Paternal education and occupation indicate familial background, which is positively related to diet quality in childhood (Darmon & Drewnowski, 2008) and parental time spent with children (Guryan, Hurst, & Kearney, 2008). The fourth indicator, utilization of medical services in childhood, is derived from a question asking whether the elderly received adequate medical care in childhood.

To reduce the influence of missing values of some variables on statistical analysis and inference, we apply the imputation approach described by Allison (2002). To test the validity of measures for childhood conditions, we apply explanatory principal component analysis with a varimax rotation. Only one factor with eigenvalues larger than 1 is generated, indicating that the four measures are loading on this factor with all factor loadings higher than 0.5.

Adulthood SES is also measured by four observed dichotomous indicators. The first indicator is respondent's current residence (1 = urban; 0 = rural). Because of the urban-rural segregation created by the *hukou* (household registration) system, Chinese urban dwellers have more advantages than do their rural counterparts, in terms of education, employment, income, social securities, and housing conditions. CLHLS data do not specify where respondents spent most of their lives in adulthood. However, rural-to-urban migration has been strictly controlled since the establishment of the *hukou* system in 1958; thus, the likelihood of permanent migration among the elderly is very low (Chan, 2010). For this reason, we include current residence to create a composite adulthood SES variable.

Education and occupation are also key markers of adulthood SES. Previous studies have found that these markers are significantly associated with elderly health and mortality (Brunner, Blane, Smith, & Marmot, 1999; Hayward & Gorman, 2004). Respondent education and primary occupation before age 60 follow the same coding as father education and occupation.

The last component of adulthood SES is a measure of the respondent's relative income, compared to peers. This measurement is based on the question, "How do you rate your economic status compared with others in your local area?" Wilkinson (1997) has shown that lower relative income can harm health by increasing psychological stress.

Results

Table 2 shows the summary statistics of the variables. On average, male elderly are about five years younger than are the female counterparts in our sample. In general, men had better childhood environments than did women. Men also belong to higher socioeconomic groups in adulthood than do women. Male advantages over women in education and occupation are especially prominent, consistent with the prior findings in China (Bauer, Wang, Riley, &

Zhao, 1992). These differences are understood within the context of a deeply rooted gender stratification system in Chinese society. Parents are more willing to invest in sons, as boys are more likely to support their parents in their old age; moreover, girls are believed to be intellectually inferior to boys (Greenhalgh, 1985; Li, 1988). It seems that men are healthier than are women at senior ages, partially because the males in our sample are much younger than their female counterparts.

Table 3 presents the estimated path coefficients from one explanatory latent variable to the dependent latent variable, based on the whole sample. The direct effect of favorable childhood circumstances on survival probability is negative and statistically significant ($c = -0.25$, $P < 0.001$). The indirect effect of childhood advantages on survival probability, through the mediating variable of adulthood SES, is estimated to be 0.29 ($P < 0.001$). We add the direct and indirect effects to get a slightly positive total effect of childhood advantages, amounting to 0.04. Adulthood SES has a significantly positive effect on survival probability ($b = 0.81$, $P < 0.001$), which implies that those in higher social classes are more likely to survive into advanced ages. The root mean square error of approximation (0.074), goodness-of-fit index (0.88), and comparative-fit index (0.98) indicate a reasonably good model fit.

According to the aforementioned theories, the mortality selection hypothesis may explain the significantly negative direct impact of favorable childhood conditions on survival probability. Extreme adversities in childhood often result in higher mortality among the least healthy members of the population in early-life stage. For example, it has been widely demonstrated that the father’s poor social class significantly increased infant mortality in underdeveloped regions (Frenzen & Hogan, 1982). Consequently, those who survive extreme childhood adversities are more robust and may have lower mortality in advanced ages than those who are not subject to such deprivations in childhood. In addition to the direct effect imposed on longevity, favorable childhood circumstances predicts improved life-course social capital, such as better education, occupation, and income. In turn, adulthood SES has a significantly positive impact on longevity. Thus, early-life advantages have a positive indirect influence on survival probability, which validates the pathways model.

After examining the impacts of childhood conditions on longevity, we quantify the effects of early-life conditions on current health status, based on the elderly sample who survived until the 2011–2012 survey. The final sample size includes 7,341 cases after excluding 4,917 cases who were interviewed in 2008–2009 but died before the 2011–2012 survey. As shown in Table 4, the direct effect of childhood conditions is insignificant. The indirect effect of favorable childhood conditions is significantly positive, though its magnitude is substantially smaller than that in Table 3. Combined, our findings indicate that childhood advantages exert a negative direct effect on survival; however, they are not directly associated with health status among the surviving elderly. Consistent with the pathways model, childhood advantages have indirect impacts on both longevity and health through the mediating factor of adulthood SES.

Table 5 and Table 6 present the SEM estimates, using the male sub-sample. There are negative direct associations between favorable childhood conditions and survival probability, as well as current health, though both coefficients are insignificant. Childhood advantages still have significantly positive indirect effects on longevity and health, equaling 0.24 and 0.28, respectively. The total effects of favorable childhood conditions for male elderly stay positive.

Table 7 and Table 8 present the SEM estimates, using the female sub-sample. The negative direct effects of childhood advantages on longevity and health are much stronger and more significant for female elderly than those for male elderly. This indicates that mortality selection is not gender-neutral, possibly because of the persistent and strong son preference in China. In societies with a strong son preference, families allocate more resources to sons, at the expense of daughters, to carry on the family line during lean times (Behrman, 1988; Das Gupta, 1987; Rose, 1999). Thus, even if they share similar childhood conditions, as shown in our data, a girl might have worse nutrition and receive less care than a boy might. Such gender discrimination increases the mortality of vulnerable female infants, thus the surviving women are more selectively robust and have a higher chance of living into advanced ages.

In addition, the indirect effects of favorable early-life circumstances on survival and health are significantly positive for female elderly, with values that are much higher than those for male elderly. This is because the effects of adulthood SES on survival and health are stronger for females. Sa´nchez-Vaznaugh, Kawachi, Subramanian, Sa´nchez, and Acevedo-Garcia (2009) and Wardle, Waller, and Jarvis (2002) similarly found that the negative SES gradient in obesity risk was steeper among women. Denton and Walters (1999) and Matthews, Manor, and Power (1999) also confirmed that education and income adequacy played a more important role in determining self-rated health and physical health for women than for men in Canada and the United Kingdom, respectively. Combining the direct and indirect effects, the total effects of childhood advantages on survival and health are also positive for women.

Discussions and Conclusions

This paper examines the direct, indirect, and total effects of childhood circumstances on survival probability and current health among Chinese elderly, with particular attention to gender differences in these effects. We draw three main conclusions from our findings. First, favorable childhood conditions, in terms of birthplace, father's education and occupation, and utilization of medical services, exert a negative direct effect on survival probability at senior ages. Thus the mortality selection hypothesis overpowers the fetal origins hypothesis. As previously noted, the mortality selection hypothesis argues that childhood adversities lead to excess mortality of the most vulnerable people and thus the surviving cohorts are more robust and more likely to survive into advanced ages, compared to those who are not exposed to such adversities in childhood. This hypothesis has also been demonstrated in Western studies. For instance, Markides and Machalek (1984) explained why black mortality rates became lower than white mortality rates after approximately age 75 in the United States. This reversal of mortality rates between advantaged and disadvantaged populations resulted from early-life high mortality for the blacks, which removed less hardy blacks from the population in early stage. In turn, the surviving blacks enjoyed a survival advantage at the oldest ages.

Second, we observe a positive indirect association between favorable childhood conditions and health and survival, through the mediator of adulthood SES. This finding is consistent with other studies (Hayward & Gorman, 2004; Laaksonen et al., 2007; Zeng et al., 2007). Childhood advantages can translate into better socioeconomic achievements in adulthood that have positive impacts for survival and health at advanced ages. The pathways model represents this finding. Combining the direct and indirect effects, the total effects of favorable childhood conditions on longevity and health stay positive, indicating that childhood advantages have a far-reaching protective influence on health into senior ages.

Third, favorable childhood conditions pose a stronger negative direct effect on survival and health for women than for men, possibly because only the hardiest women can survive difficult times in societies with a strong son preference. In developing countries with a son preference, such as India, boys are treated better than are girls in disadvantaged families (Das Gupta et al., 2003). This phenomenon has also been documented in developed countries, such as the United States (Johnson, Johnson, Wang, Smiciklas-Wright, & Guthrie, 1994; Xie, Gilliland, Yu-Fen, & Rockett, 2003). This might lead to a stronger selection of healthy and genetically robust females. Furthermore, the positive indirect effects of favorable childhood conditions on survival and health also appear stronger for women, as adulthood SES exerts greater effects on survival and health for women. Previous studies have also discovered steeper socioeconomic gradients in health among women (Denton & Walters, 1999; Sa´nchez-Vaznaugh et al., 2009; Wardle et al., 2002), though there has been little exploration of the reasons for gender disparities.

While this study innovatively applies structural equation modeling to illustrate the “long arm” of childhood conditions in the largest developing country, we caution against over-interpretation. First, similar to a majority of surveys of the elderly, we are unable to track individuals from childhood into the oldest-old ages. The information on childhood conditions and adulthood SES are collected retrospectively with inevitable recall errors. Second, we account for adulthood SES as the mediating variable in the association between early-life conditions and late-life health. Childhood conditions are linked to a web of pathways, such as adulthood lifestyle, that ultimately influence late-life health. We estimate the SEM to include adult lifestyle, measured by smoking and heavy drinking, as the second mediating variable. However, the results show that lifestyle has an insignificant effect on health outcomes, possibly because of the reversed causal impact of health on lifestyle: unhealthy lifestyles may lift the risk of morbidity and mortality on one hand, and poor health may force people to give up smoking and heavy drinking on the other hand. Thus, we retain adulthood SES as the only mediating variable.

Even with these limitations, our study enriches the current literature in the following aspects. First, to our knowledge, this is the first study to quantify the direct, indirect, and total effects of childhood conditions on survival probability and health status at senior ages, using the SEM. Though the direct and indirect effects are in the opposite direction, the total effects of favorable childhood conditions remain positive for both male and female elderly. Second, our focus on China may provide a useful reference for other developing and transitional economies. China is the largest developing country, and although it is undergoing rapid economic growth, it has rising income inequalities. Economic growth improves the overall living conditions for children, but increasing income inequalities trap some children in relative poverty. Our findings suggest that the socioeconomic environment throughout the life course can influence late-life mortality and morbidity. Public policies that target childhood wellbeing could effectively improve socioeconomic achievements in adulthood and, in turn, promote good health at senior ages.

References

Allison, PD. Missing data. Thousand Oaks, CA: Sage; 2002.

Ames SL, Sussman S, Dent CW, Stacy AW. Implicit cognition and dissocative experiences as predictors of adolescent substance use. The American Journal of Drug and Alcohol Abuse. 2005; 35(1):129–162. [PubMed: 15768575]

Barberger-Gateau P, Fabrigoule C, Helmer C, Rouch I, Dartigues JF. Functional impairment in instrumental activities of daily living: an early clinical sign of dementia? Journal of the American Geriatrics Society. 1999; 47(4):456–462. [PubMed: 10203122]

Barker DJ, Martyn CN. The maternal and fetal origins of cardiovascular disease. Journal of Epidemiology and Community Health. 1992; 46(1):8–11. [PubMed: 1573367]

Barker DJ, Osmond C, Winter PD, Margetts B, Simmonds SJ. Weight in infancy and death from ischaemic heart disease. Lancet. 1989; 334(8663):577–580. [PubMed: 2570282]

Bauer J, Wang F, Riley NE, Zhao X. Gender inequality in urban China: education and employment. Modern China. 1992; 18(3):333–370.

Behrman J. Intrahousehold allocation of nutrients in rural India: are boys favored? Do parents exhibit inequality aversion? Oxford Economic Papers. 1988; 40(1):32–54.

Bengtsson T, Brostrom G. Do conditions in early life affect old-age mortality directly and indirectly? Evidence from 19th-century rural Sweden. Social Science and Medicine. 2009; 68(9):1583–1590. [PubMed: 19286293]

Bollen, KA. Total, direct, and indirect effects in structural equation models. In: Clogg, CC., editor. Sociological methodology. Washington DC: American Sociological Association; 1987. p. 37-69.

Brunner E, Blane S, Smith D, Marmot D. When does cardiovascular risk start? Past and present socioeconomic circumstances and risk factors in adulthood. Journal of Epidemiology and Community Health. 1999; 53(12):757–764. [PubMed: 10656084]

Byrne, BM. Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming. Mahwah, NJ: Lawrence Erlbaum Associates, Inc; 1998.

Chan KW. The household registration system and migrant labor in China: notes on a debate. Population and Development Review. 2010; 36(2):357–364. [PubMed: 20734556]

Chen, HS. Data quality evaluations of the 2008 wave of Chinese longitudinal healthy longevity survey. In: Zeng, Y., editor. Research on elderly population, family, health and care needs/cost. Beijing: Science Press; 2010. p. 351-361.(In Chinese)

Darmon N, Drewnowski A. Does social class predict diet quality? The American Journal of Clinical Nutrition. 2008; 87(5):1107–1117. [PubMed: 18469226]

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

Das Gupta M, Jiang Z, Li B, Xie Z, Chung W, Hwa-Ok B. Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. The Journal of Development Studies. 2003; 40(2):152–187.

Denton M, Walters V. Gender differences in structural and behavioral determinants of health: an analysis of the social production of health. Social Science & Medicine. 1999; 48(9):1221–1235. [PubMed: 10220021]

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

Folstein MF, Folstein SE, McHugh PR. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research. 1975; 12(3):189–198. [PubMed: 1202204]

Frenzen PD, Hogan DP. The impact of class, education, and health care on infant mortality in a developing society: the case of rural Thailand. Demography. 1982; 19(3):391–408. [PubMed: 7117632]

Gagnon M, Letenneur L, Dartigues J, Commenges D, Orgogozo J, Barberger-Gateau P, Alpérovitch A, Décamps A, Salamon R. Validity of the mini-mental state examination as a screening instrument for cognitive impairment and dementia in French elderly community residents. Neuroepidemiology. 1990; 9(3):143–150. [PubMed: 2402325]

Galobardes B, Lynch JW, Smith GD. Is the association between childhood socioeconomic circumstances and cause-specific mortality established? Update of a systematic review. Journal of Epidemiology and Community Health. 2008; 62(5):387–390. [PubMed: 18413449]

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

Grant MD, Piotrowski ZH, Chappell R. Self-reported health and survival in the longitudinal study of aging, 1984–1986. Journal of Clinical Epidemiology. 1995; 48(3):375–387. [PubMed: 7897459]

Greenhalgh S. Sexual stratification: the other side of “growth with equity” in East Asia. Population and Development Review. 1985; 11(2):265–314.

Guryan, J.; Hurst, E.; Kearney, MS. Parental education and parental time with children (NBER Working Paper 13993). Cambridge, MA: National Bureau of Economic Research; 2008. from http://www.nber.org/papers/w13993 [Retrieved May 2008]

Hamil-Luker J, O’Rand AM. Gender differences in the link between childhood socioeconomic conditions and heart attack risk in adulthood. Demography. 2007; 44(1):137–158. [PubMed: 17461340]

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]

Huang C, Elo IT. Mortality of the oldest old Chinese: The role of early-life nutritional status, socio-economic conditions, and sibling sex-composition. Population Studies. 2009; 63(1):7–20. [PubMed: 19184718]

Johnson RK, Johnson DG, Wang MQ, Smiciklas-Wright H, Guthrie HA. Characterizing nutrient intakes of adolescents by sociodemographic factors. Journal of Adolescent Health. 1994; 15(2): 149–154. [PubMed: 8018688]

Kuh D, Hardy R, Langenberg C, Richards M, Wadsworth MEJ. Mortality in adults aged 26–54 years related to socioeconomic conditions in childhood and adulthood: post war birth cohort study. British Medical Journal. 2002; 325:1076–1080. [PubMed: 12424168]

Laaksonen M, Silventoinen K, Martikainen P, Rahkonen O, Pitkaniemi J, Lahelma E. The effects of childhood circumstances, adult socioeconomic status, and material circumstances on physical and mental functioning: a structural equation modelling approach. Annals of Epidemiology. 2007; 17(6):431–439. [PubMed: 17395480]

Li Y. More attention should be paid to the education of girls. People’s Education. 1988; 7:12–13. (In Chinese).

Markides KS, Machalek R. Selective survival, aging, and society. Archives of Gerontology and Geriatrics. 1984; 3(3):207–222. [PubMed: 6395820]

Marmot M, Brunner S, Hemingway S. Relative contributions of early life and adult socioeconomic factors to adult morbidity in the Whitehall II study. Journal of Epidemiology and Community Health. 2001; 55(5):301–307. [PubMed: 11297647]

Matthews S, Manor O, Power C. Social inequalities in health: are there gender differences? Social Science & Medicine. 1999; 48(1):49–60. [PubMed: 10048837]

Mi X, Eskridge KM, George V, Wang D. Structural equation modeling of gene-environment interactions in coronary heart disease. Annals of Human Genetics. 2011; 75(2):255–265. [PubMed: 21241273]

Mossey JM, Shapiro E. Self-rated health: a predictor of mortality among the elderly. American Journal of Public Health. 1982; 72(8):800–808. [PubMed: 7091475]

Mu R, Zhang X. Why does the Great Chinese Famine affect the male and female survivors differently? Mortality selection versus son preference. Economics and Human Biology. 2011; 9(1):92–105. [PubMed: 20732838]

Nourhashémi F, Andrieu S, Gillette-Guyonnet S, Vellas B, Albarèe JL, Grandjean H. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS study). The Journals of Gerontology: Series A. 2001; 56(7):M448–M453.

O'Rand AM, Hamil-Luker J. Processes of cumulative adversity: childhood disadvantage and increased risk of heart attack across the life course. Journals of Gerontology: Psychological Sciences & Social Sciences. 2005; 60B(Special Issue II):117–124.

Ozanne SE, Hales CN. Lifespan: catch-up growth and obesity in male mice. Nature. 2004; 427:411–412. [PubMed: 14749819]

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]

Rose E. Consumption smoothing and excess female mortality in rural India. Review of Economics and Statistics. 1999; 81(1):41–49.

Sa´nchez-Vaznaugh EV, Kawachi I, Subramanian SV, Sa´nchez BN, Acevedo-Garcia D. Do socioeconomic gradients in body mass index vary by race/ethnicity, gender and birthplace? American Journal of Epidemiology. 2009; 169(9):1102–1112. [PubMed: 19299405]

Shen, K. Data quality evaluations of the 2008 wave for the deceased elderly from Chinese longitudinal healthy longevity survey. In: Zeng, Y., et al., editors. Research on elderly population, family, health and care needs/cost. Beijing: Science Press; 2010. p. 361-364.(In Chinese)

Shen RS. Distribution of Chinese cities. Acta Geographica Sinica. 1937; 4(1):915–936. (In Chinese).

Sobel ME. Direct and indirect effects in linear structural equation models. Sociological Methods Research. 1987; 16(1):155–176.

Turner HA, Butler MJ. Direct and indirect effects of childhood adversity on depressive symptoms in young adults. Journal of Youth and Adolescence. 2003; 32(2):89–103.

Wardle J, Waller J, Jarvis MJ. Sex differences in the association of socioeconomic status with obesity. American Journal of Public Health. 2002; 92(8):1299–1304. [PubMed: 12144988]

Wilkinson RG. Socioeconomic determinants of health. Health inequalities: relative or absolute material standards? The British Medical Journal. 1997; 314:591–595. [PubMed: 9055723]

Xie B, Gilliland FD, Yu-Fen L, Rockett H. Effects of ethnicity, family income, and education on dietary intake among adolescents. Preventive Medicine. 2003; 36:30–40. [PubMed: 12473422]

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]

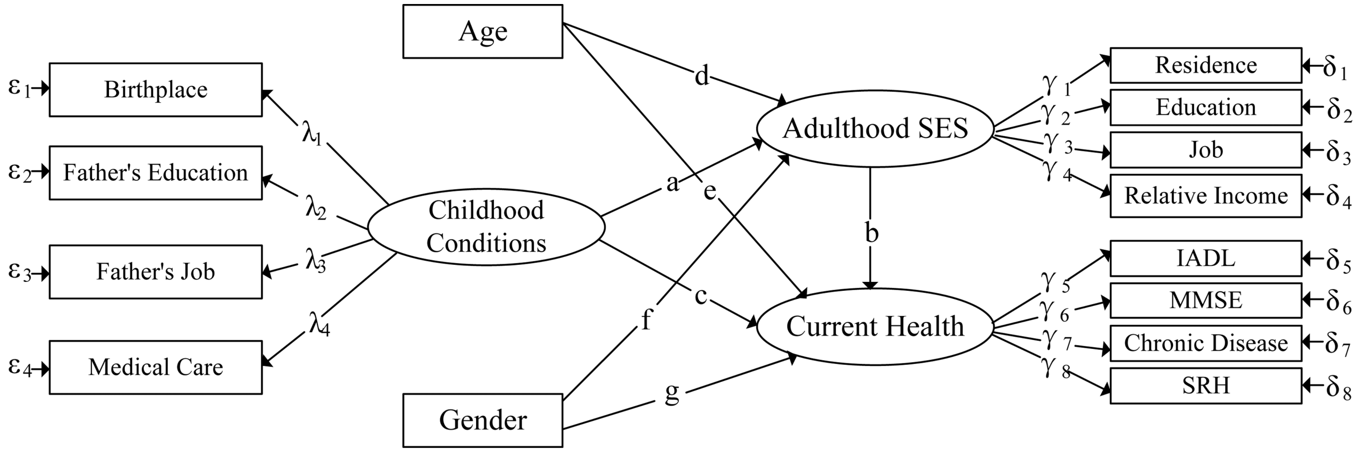

Fig. 1. Structural equation model of childhood conditions, adulthood socioeconomic status (SES), and current health at old ages

Note: When estimating the direct and indirect effects of childhood conditions on survival probability, the latent variable "Current Health" is measured by a dichotomous indicator "survival or not."

Author Manuscript

Author Manuscript

Author Manuscript

Table 1

Sample distributions of the 2008–2009 wave of the Chinese Longitudinal Healthy Longevity Survey

Age Group	Male	Female	Total
65–69	539	509	1,048
70–79	1,162	1,070	2,232
80–89	1,633	1,601	3,234
90–99	1,442	1,956	3,398
100+	471	1,875	2,346
Total	5,247	7,011	12,258

Table 2

Descriptive statistics of the sample

	Male	Female
Demographic characteristics		
Mean age	84.4	89.1
Childhood conditions		
Birthplace		
Urban	12.5%	10.8%
Rural	87.5%	89.2%
Father’s education		
At least 1 year of schooling	19.9%	14.9%
Illiterate	80.1%	85.1%
Father’s occupation in childhood		
Non-manual occupation	3.0%	2.7%
Manual occupation	97.0%	97.3%
Received adequate medical care when ill in childhood		
Yes	37.5%	31.9%
No	62.5%	68.1%
Adulthood socioeconomic status		
Current residence		
Urban	39.6%	37.5%
Rural	60.4%	62.5%
Education		
At least 1 year of schooling	63.1%	17.5%
Illiterate	36.9%	82.5%
Primary occupation before age 60		
Non-manual occupation	14.4%	2.6%
Manual occupation	85.6%	97.4%
Relative income compared with peers		
Rich	15.2%	11.9%
Poor	84.8%	88.1%
Current health outcomes		
Instrumental activities of daily living		
Independent	27.4%	13.5%
Dependent	35.6%	44.0%
Deceased	37.0%	42.5%
Mini-Mental State Examination		
Normal cognition	46.2%	30.4%
Impaired cognition	16.8%	27.1%
Deceased	37.0%	42.5%
Chronic diseases		
No chronic disease	37.6%	34.5%

	Male	Female
At least 1 chronic diseases	25.4%	23.1%
Deceased	37.0%	42.5%
Self-rated health		
Good	28.8%	22.8%
Poor	34.2%	34.7%
Deceased	37.0%	42.5%
Sample size	5,247	7,011

Note: Age, childhood conditions, and adulthood socioeconomic status are measured in the 2008–2009 survey, and current health outcomes are measured in the 2011–2012 survey.

Table 3

Estimates of direct, indirect, and total effects of childhood and adulthood conditions on survival probability, based on the whole sample (N = 12,258)

Dependent latent variable	Independent latent variables and control variables	Direct effect on health (A)	Indirect effect on health via adulthood SES (B)	Total effect on health (A + B)
Survival probability	Childhood conditions	c = −0.25***	a × b = 0.36 × 0.81 = 0.29***	0.04
	Adulthood SES	b = 0.81***	N.A.	0.81
	Age	e = −0.55***	d × b = −0.05 × 0.81 = −0.04***	−0.59
	Male	g = −0.21***	f × b = 0.20 × 0.81 = 0.16***	−0.05
Adulthood SES		Effects on adulthood SES		
	Childhood conditions	a = 0.36***		
	Age	d = −0.05***		
	Male	f = 0.20***		

Note:

* $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$.

Goodness of model fit: Root mean square error of approximation = 0.074; goodness-of-fit index = 0.98; comparative-fit index = 0.88.

Table 4

Estimates of direct, indirect, and total effects of childhood and adulthood conditions on current health outcomes, based on the sample who survived until the 2011–2012 survey (N = 7,341 cases)

Dependent latent variable	Independent latent variables and control variables	Direct effect on health (A)	Indirect effect on health via adulthood SES (B)	Total effect on health (A + B)
Current Health	Childhood conditions	c = −0.01	a × b = 0.36 × 0.49 = 0.18***	0.17
	Adulthood SES	b = 0.49***	N.A.	0.49
	Age	e = −0.56***	d × b = −0.06 × 0.49 = −0.03***	−0.59
	Male	g = 0.09**	f × b = 0.21 × 0.49 = 0.10***	0.19
Adulthood SES		Effects on adulthood SES		
	Childhood conditions	a = 0.36***		
	Age	d = −0.06***		
	Male	f = 0.21***		

Note:

*P < 0.05;

**P < 0.01;

***P < 0.001.

Goodness of model fit: Root mean square error of approximation = 0.066; goodness-of-fit index = 0.99; comparative-fit index = 0.99.

Table 5

Estimates of direct, indirect, and total effects of childhood and adulthood conditions on survival probability, based on the male sub-sample (N = 5,247 cases)

Dependent latent variable	Independent latent variables and control variables	Direct effect on healtd (A)	Indirect effect on healtd via adultdood SES (B)	Total effect on healtd (A + B)
Survival probability	Childhood conditions	c = −0.14	a × b = 0.65 × 0.37 = 0.24***	0.10
	Adulthood SES	b = 0.37***	N.A.	0.37
	Age	e = −0.52***	d × b = −0.05 × 0.37 = −0.02***	−0.54
Adulthood SES		Effects on adulthood SES		
	Childhood conditions	a = 0.65***		
	Age	d = −0.05***		

Note:

* $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$.

Goodness of model fit: Root mean square error of approximation = 0.080; goodness-of-fit index = 0.98; comparative-fit index = 0.81.

Table 6

Estimates of direct, indirect, and total effects of childhood and adulthood conditions on current health outcomes, based on the male sub-sample who survived until the 2011–2012 survey (N = 3,306 cases)

Dependent latent variable	Independent latent variables and control variables	Direct effect on healtd (A)	Indirect effect on healtd via adultdood SES (B)	Total effect on healtd (A + B)
Current health	Childhood conditions	$c = -0.07$	$a \times b = 0.59 \times 0.47 = 0.28^{***}$	0.21
	Adulthood SES	$b = 0.47^{***}$	N.A.	0.47
	Age	$e = -0.61^{***}$	$d \times b = -0.05 \times 0.47 = -0.02^{***}$	−0.63
Adulthood SES		Effects on adulthood SES		
	Childhood conditions	$a = 0.59^{***}$		
	Age	$d = -0.05^{***}$		

Note:

*P < 0.05;

**P < 0.01;

***P < 0.001.

Goodness of model fit: Root mean square error of approximation= 0.078; goodness-of-fit index = 0.97; comparative-fit index = 0.77.

Author Manuscript

Author Manuscript

Author Manuscript

Table 7

Estimates of direct, indirect, and total effects of childhood and adulthood conditions on survival probability, based on the female sub-sample (N = 7,011 cases)

Dependent latent variable	Independent latent variables and control variables	Direct effect on health (A)	Indirect effect on health via adulthood SES (B)	Total effect on health (A + B)
Survival probability	Childhood conditions	$c = -0.71^{**}$	$a \times b = 0.57 \times 1.26 = 0.72^{***}$	0.01
	Adulthood SES	$b = 1.26^{***}$	N.A.	1.26
	Age	$e = -0.46^{***}$	$d \times b = -0.10 \times 1.26 = -0.13^{***}$	−0.59
Adulthood SES		Effects on adulthood SES		
	Childhood conditions	$a = 0.57^{***}$		
	Age	$d = -0.10^{***}$		

Note:

*P < 0.05;

**P < 0.01;

***P < 0.001.

Goodness of model fit: Root mean square error of approximation= 0.066; goodness-of-fit index = 0.99; comparative-fit index = 0.87.

Table 8

Estimates of direct, indirect, and total effects of childhood and adulthood conditions on current health outcomes, based on the female sub-sample who survived until the 2011–2012 survey (N = 4,035 cases)

Dependent latent variable	Independent latent variables and control variables	Direct effect on health (A)	Indirect effect on health via adulthood SES (B)	Total effect on health (A+B)
Current health	Childhood conditions	$c = -0.46^{**}$	$a \times b = 0.60 \times 1.06 = 0.64^{***}$	0.18
	Adulthood SES	$b = 1.06^{***}$	N.A.	1.06
	Age	$e = -0.46^{***}$	$d \times b = -0.10 \times 1.06 = -0.11^{***}$	−0.57
Adulthood SES		Effects on adulthood SES		
	Childhood conditions	$a = 0.60^{***}$		
	Age	$d = -0.10^{***}$		

Note:

* P < 0.05;

** P < 0.01;

*** P < 0.001.

Goodness of model fit: Root mean square error of approximation= 0.066; goodness-of-fit index = 0.99; comparative-fit index = 0.87.