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Article

Life course influences on later life health in China: Childhood health exposure and socioeconomic mediators during adulthood

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ABSTRACT

China's unprecedented population aging and social and economic change raise important issues concerning life course determinants of advantage or disadvantage into later life. Data from the China Health and Retirement Longitudinal Study (CHARLS) 2013 were analysed to identify the influence of childhood health on later life health as indicated by self-rated health and how this influence could be mediated by social and economic positions (SEP) and resources later in the life span. CHARLS provides nationally representative data on 18,000 individuals aged 45 years and above in approximately 150 districts and 450 villages. Both multivariate logit regression model and KHB method (Karlson/Holm/Breen method) were applied to examine and decompose the life span influences on later life health. The results show that the childhood health, accounts for approximately half of the effect directly and another half of the effect indirectly through social and economic variations during adulthood. Relative living standard, marital status and urban residence are the most significant and important social and economic mediators for men; For women, living standard and secondary schooling are most influential while marital status is not significant. Implications for social and economic policies to improve later life health are discussed.

1. Introduction

Population aging in China is unprecedented in terms of its magnitude and rapidity and also in terms of massive social and economic changes. The productivity and wellbeing of the world will be critically influenced by the health capacities of the increasing numbers of aging people (World Bank, 2014; WHO 2015). In China since the 1950s important improvements in the social determinants of health have been underpinned by government-led action towards social egalitarianism and equal opportunity during the early Mao years, socio-economic development during reforms, and the benefits of societal impacts of the one child policy since 1979. There is increasing social and policy recognition that population aging will be a fundamental factor not only in the wellbeing of aging individuals but also in the productivity of the economy and demands on health and aged care services. These are critical issues in China accentuated by its large population and the one child policy (United Nations, 2013; Zhao, Smith & Strauss, 2014).

Concepts in life span epidemiology provide an important framework for investigating ways in which individual and social change influence the health of aging people (Ben-Shlomo, Cooper & Kuh, 2016). On the one hand aging individuals progress in variable ways through their life course with continuing effects on health related to socio-economic exposures in their family, health, and work experiences from childhood through adulthood. On the other hand, these experiences are structured by opportunities and constraints in socio-economic environments that impact on people's health and evolve during successive periods of history. The interplay between individual and societal factors has consequences for health outcomes at all ages, impacting later life health directly (e.g. stress and pollution) and indirectly through financial and social resources as well as the availability of health services (Kendig & Nazroo 2016). Understanding cumulative processes of advantage and disadvantage over the life course and between generations (Dannefer, 2003; Dannefer & Kelley-Moore 2009) is important for elucidating long-term and persistent inequalities in health outcomes over time.

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1.1. Social and economic change in contemporary China

The current cohort of aging Chinese have had lives shaped by the tremendous social change in China before and after WWII. These include intense deprivation during the pre-war Japanese occupation, the Civil War, continuing famine and turmoil during the early Mao years, and subsequent urbanisation, industrialisation, and (eventually) rising living standard (Gong, Leigh & Meng, 2012). Life expectancy at birth rose dramatically from 43 years in 1960 (the earliest available) to 76 years in 2014 according to World Bank World Development Indicators.¹

The Mao era's ideology of "equal access for equal need" in health care (Gibson, 1972) and education applied political and community pressures to direct scarce health resources to the prevention of infectious diseases in rural areas and delivery of primary care for workers and rural residents (Gibson, 1972; Gong et al., 2012). Major economic reforms initiated in the late 1970s and early 1980s drove further changes in China, including massive and uneven urbanisation, industrialisation, the one-child policy, and educational investment, all with consequences for rising living standards and income inequality (Gong et al., 2012; Xie & Zhou, 2014). The economic reforms in China began from the private sector in the eastern regions and then progressed to the public sector and other regions, leading to increasing inequalities across Chinese society (Yeatts et al., 2013) and increasingly uneven development between urban and rural areas (Xu, Shi & Huang, 2014). After the introduction of the new rural cooperative insurance in 2003, coverage of medical insurance increased dramatically to 96% of all Chinese, although significant inequalities persist in outpatient services and hospitalization (Gong, Kendig & He, 2016), out-of-pocket payment (Wang & Zheng, 2014), and premium contributions (Li & Zhang, 2013) by health insurance type.

1.2. Social determinants of health

The World Health Organization's (WHO) efforts on social determinants of health and wellbeing in developing countries have concentrated on the earlier stages of the life span as a key priority for social investment. The WHO (2008) report 'Closing the gap in a generation report' calls for achieving '... healthy equity through action on the social determinants of health' and creating '... conditions for a flourishing older life'. This aligns with the life course approach to later life health research (Dannefer, 2003; Ben-Shlomo et al., 2016). The limited evidence on social and economic determinants of health throughout the lifespan has generally focused on Western or high income settings (Hertzman, Power, Matthews & Manor, 2001; Kendig & Nazroo, 2016).

In the social determinants literature, social and economic position (SEP) has been measured by parent's education and occupation in childhood, educational attainment and income or expenditure in adulthood, and use of health care resources (Yip et al., 2007; Lei et al., 2014; Shen & Zeng, 2014). Education, household expenditure, lifestyle behaviours and psychosocial factors has been found to be important to maintain good health and prevent chronic diseases in later life (Hu, Liu & Willett, 2011; Lei et al., 2014; Cai, Coyte & Zhao, 2017). Additional factors reported to be related to later life health in China include whether both parents were alive at age 10, social engagement, religious involvement, receiving adequate medical service, marital status, and urban or rural area of residence (Zeng, Gu & Land, 2007; Wen & Gu, 2011; Lei et al., 2014; Shen & Zeng, 2014).

Previous life course studies in China have reported: childhood disadvantageous exposure is associated with poor health and socio-economic status (SES) in middle to later life (Zeng et al., 2007; Smith, Shen, Strauss, Zhe & Zhao, 2012); childhood SES improves adult SES and thus indirectly promotes longevity and health in advanced age (Shen & Zeng, 2014); both childhood and adult socioeconomic

conditions affect mortality, cognitive impairment and self-rated health directly and indirectly among older adults (Wen & Gu, 2011).

These studies have notable limitations. For instance, some were based on local or regional data in China (Zeng et al., 2007; Wen & Gu, 2011; Smith et al., 2012), or covered only specific age groups, such as the oldest-old cohort aged 80 and plus, Zeng et al. (2007) and Shen and Zeng (2014), or those aged 65–79 by Wen and Gu (2011). To date, Smith et al. (2012) is one of the few studies that have investigated the association between childhood health and later life health in China but the ways in which further midlife experiences impact on these associations require further examination in a more complete life span analysis. Wen and Gu (2011) used the difference method (Valeri & VanderWeele, 2013) to examine how the adulthood social and economic advantages could change the influences of early life disadvantages on late life health and socio-economic outcomes.² However, this difference method has notable limitations by not considering the existence of exposure-mediator interactions and nonlinearities in the model (Breen, Karlson & Holm, 2013). The aim of our present study is to examine the influence of childhood health on later life health and how this influence could be decomposed into direct and indirect effects, through the mediation of social and economic positions and resources in the later life span. We first follow the difference method used by Wen and Gu (2011), to build successive multivariate logistic regression models to test and elucidate possible cumulative life-stage effects on later life health. We then use the more rigorous KHB method (Karlson/Holm/Breen method, see Kohler, Karlson and Holm (2011), Breen et al. (2013)) to provide unbiased decompositions of the direct and indirect influences³ for the whole sample, as well as by gender after considering exposure-mediator interactions. The findings potentially can inform multi-sector policies that target priority groups and actions over the life span to more equitably improve the health of ageing men and women to better prepare China and other developing and middle income countries in their aging population.

2. Data, measurement and method

This paper draws on the nationally representative China Health and Retirement Longitudinal Study (CHARLS) of Chinese aged 45 years and over who were born from the early 1920s to the late 1960s. The primary dependent variable is self-rated general health which has been used widely for comparative studies of aging, health, and wellbeing in Asian and western countries (e.g. French et al., 2012), as well as in China (Lei et al., 2014).

Although the CHARLS data do not permit a full investigation of individual life history influences on aging, they do provide retrospective individual data on health and socio-economic at selected points earlier in respondents' lives (Zhao et al., 2014). As our study focuses on individual life span social determinants, we do not examine socioeconomic influences at the community level such as pollution, per capita gross domestic product (GDP), and the neighbourhood environment.

2.1. Data source

The CHARLS study 2013 was conducted by the China Centre for Economic Research of Peking University (Zhao et al., 2014). Face-to-face interviews in respondents' homes collected detailed information on demographic characteristics, social and economic conditions, and health and health-related behaviours. In the first wave of CHARLS in 2011, participants were randomly sampled using a multi-stage probability-proportional-to-size technique, stratified by regions and then by

² This method is called as the difference method because it compares the differences of the estimated coefficients between nested models.

³ KHB method provides unbiased decomposition of the direct and indirect influences for the non-linear models when compared to the difference method.

¹ <http://data.worldbank.org/indicator/SP.DYN.LE00.IN>

urban districts or rural counties and per capita GDP. In the second wave in 2013, a total of 18246 respondents aged 45 and plus were surveyed, in which 14988 were from Wave 1. Missing values had not been imputed in the survey data before its availability to the public. Individual weights denoting the inverse of the probability that the observation are included because the sampling design with household and individual non-response adjustments, are used for analysis.

2.2. Health and socio-economic measures

Following the life span social determinants of health approach, we have first investigated a range of health, social and economic variables at different life stages which might influence late life health.⁴ We then apply two criteria as suggested by Valeri and VanderWeele (2013) to select the most important mediators, by examining, (1) whether the early, middle to late life social and economic variables are predicted significantly by childhood health exposure; (2) whether the health outcome (self-rated health at later life) is significantly predicted by the early life health exposure, social and economic mediators and covariates (age, gender and ethnicity). We found that educational attainment, urban residence, relative living standard, and medical insurance schemes during adulthood are the most important social and economic mediators with significant coefficients and R-square equal or more than 0.01 in the univariate regression model. Below we detail our selected health and social economic measures used in our final analyses.

2.2.1. Health measures

Self-rated health was asked in two ways in order to identify the effect of question format: asking half of the respondents “Would you say your health is excellent, very good, good, fair and poor?” and the other half “Would you say your health is very good, good, fair, poor and very poor?”⁵ The two scales of self-rated health are combined into one scale: “good health or above” and “fair or poor health”. Self-rated health, as a global subjective indicator, was found to be significantly correlated with the presence of chronic diseases (0.20), physical disability (0.10), functional loss (0.13), any Activities of Daily Living difficulty (0.32), any Instrumental Activities of Daily Living difficulties (0.24), depression (0.27), poor memory (0.12) and level of pain (0.33).

Childhood health was measured by asking “How would you evaluate your health during childhood, up to and including age 15, excellent, very good, good, fair, poor?” This retrospective self-evaluation health measure has been found to be a good summary measure of overall childhood health in the context of the United States, where it was found to be highly correlated to the retrospective presence of many physical diseases and psychological problems at childhood (Smith et al., 2012).

2.2.2. Social and economic position and resources during adulthood

Respondent’s educational attainment is the most important SEP influencing adults’ entry and attainment in the labour market in early to middle life hence impacting their later life health.⁶ **Current social and**

⁴ We decided to focus on the childhood health exposure only (excluding early life parental SES exposures) because parental information in CHARLS has not been collected for those parents who were dead or whose own children who were not at home during the survey to provide their information. Imputation itself for a large sub sample would generate bias, especially if used as key exposure. The group of social and economic variables that we had initially examined included early to middle life social and economic positions (e.g. parental and individual education attainment, and current social and economic resources (household expenditure, perceived relative living standard, medical insurance, communist party membership, urban or rural residence and marital status).

⁵ CHARLS collected self-rated health information using different formats in order to test whether the form of the questions impacts on respondents’ answer.

⁶ Although occupation is an important SEP measure in the developed countries, it was not collected for respondents in CHARLS.

economic resources are measured by a group of variables which could influence health and health services use.⁷ These include:

- **The self-rated relative living standard**, which is measured by asking “Compared to the average living standard of people in your city or county, how would you rate your standard of living, much better, a little better, about the same, a little worse, much worse?” We group the answers into three categories to simplify the model estimation as we did not find any better discernment by using more categories. The relative living standard aims to take account of the significant difference in living costs across regions in China.⁸
- **Different types of medical insurance**, in which government medical insurance and urban employee basic medical insurance (UEBMI), have more benefits than the urban resident basic medical insurance (URBMI) and the new cooperative medical scheme (NCMS).
- **Urban or rural residence**, as an indicator of the dual economy, with large variations in social and economic development as well as access to health facilities and services;
- **Marital status**, as an important family resource for informal care and emotional support. Nearly all Chinese have been married but the proportion without a spouse is very high at older age.

2.3. Analytical approach

We first conduct descriptive analyses of all variables by age and gender (Table 1); examine the correlations among the exposure, mediators and other covariates (Table 2); and then apply life course concepts and multivariate binary logit regression model (Zeng et al., 2007; Wen & Gu, 2011) to explore the most important and significant social mediators on self-rated health in later life (Table 3). KHB method is lastly used to decompose the direct and indirect influences by gender with and without controls for exposure-mediator interactions (Kohler et al., 2011; Breen et al., 2013; Valeri & VanderWeele, 2013).

The hierarchical additive models introduce variables according to exposures and mediators at successive life stages. In the models, childhood health is the early life exposure, self-rated health is the later life outcome, while the adulthood SEP and resources, are mediators (Valeri & VanderWeele, 2013).⁹ Age, gender and ethnicity are covariates with impact on exposures, mediators and outcomes. They are controlled for in the models (Richiardi, Bellocco & Zugna, 2013; Valeri & VanderWeele, 2013).

Models 1 is used to investigate the total effects of key early life health exposure (childhood health here) on later life health outcome (self-rated health); Models 2 to 3 check whether the effect of early life exposure act through a given set of mediators (indirect impacts) or are unexplained by these mediators (direct impact). This hierarchical estimation approach allows us to examine how the influence of earlier life stage variable may change once mediators are applied for later life stage variables in the model (Wen & Gu, 2011; Richiardi et al., 2013). In order to check the robustness of our results in terms of missing information of the key variable “relative living standard”, Model 3 uses living standard with a category “Not reported”, while Model 4 uses the variable with imputed values. The same sample size is used for all models in order to make the coefficients as much as comparable across the models. The significance of exposure-mediator interactions has been examined and reported in Table 4.

⁷ Household expenditure and communist party membership were initially included. Household expenditure is deleted now as it became not significant after controlling for relative living standard. Communist party membership is deleted from final analysis as it is not the most important mediators according to the two selection criteria in Valeri and VanderWeele (2013).

⁸ Self-rated relative living standard was not collected for about 3500 new respondents in the 2013 survey. The missing value of relative living standard is imputed by age, gender, ethnicity, communist membership, educational attainment, marital status, urban residence and household expenditure.

⁹ For more information on how the exposures, mediators and outcomes are defined and influence each other, see Figures 1 and 2 in Valeri and VanderWeele (2013).

Table 1
Sample size and weighted proportions by population characteristics, CHARLS 2013.
Source: CHARLS 2013, individual weights are used.

By age and gender			Sample size and weighted proportions					
			All	Aged 45–59 %	Aged 60–74 %	Aged 75+ %	Men %	Women %
Control variables	All	Sample size	18169	9281	7283	2002	8790	9410
	Age		100	51.4	38.1	10.5		
	Gender		100				48.4	51.6
	Ethnicity	Han majority	92.4	91.9	92.6	93.9	93.1	91.7
		Other minorities	7.6	8.2	7.4	6.1	6.9	8.3
Later life self-rated health	Current perceived health	Fair/poor	27.0	22.2	31.4	34.7	22.9	30.8
		Good	73.0	77.9	68.6	65.3	77.1	69.2
Childhood health	Perceived health before age 16	Fair/poor	24.4	24.1	25.6	21.3	23.3	25.5
		Good	75.6	75.9	74.4	78.7	76.7	74.5
SEP and resources in adulthood	Individual educational attainment	Under primary schooling	44.8	32.4	53.1	75.7	31.1	57.7
		Second schooling	53.0	64.9	45.4	22.1	66.0	40.7
		College and above degree	2.2	2.7	1.5	2.2	2.9	1.5
	Perceived relative living standard	Better than the average	3.6	3.3	3.5	6.1	4.4	2.9
		About the average	28.1	29.0	26.9	28.2	28.3	27.8
		Worse than the average	68.4	67.7	69.7	65.7	67.4	69.3
	Health insurance	Government insurance	1.3	0.7	1.6	2.8	1.9	0.7
		Urban employee insurance	11.7	10.3	13.5	11.6	14.5	9.0
		Urban resident insurance	5.2	5.6	4.5	5.8	4.4	5.9
		New rural cooperative insurance	72.1	72.0	72.7	69.9	69.6	74.4
		Commercial insurance	2.2	3.5	1.0	0.4	2.3	2.2
		Other	3.2	3.3	3.3	2.1	3.3	3.1
	Area of residence	No	4.4	4.6	3.3	7.3	4.1	4.7
		Rural	58.7	57.8	60.7	56.2	58.8	58.7
	Marital status	Urban	41.3	42.2	39.3	43.8	41.2	41.3
Married with spouse present		78.6	85.4	78.9	44.8	82.4	75.1	
	Married with spouse away	6.2	8.3	4.5	1.9	6.4	5.9	
	Separated/Divorced/Widowed	14.2	5.4	15.5	52.5	9.4	18.7	
	Never married	1.0	1.0	1.2	0.8	1.9	0.2	

Table 2
Spearman’s rank correlation among selected variables in the final analysis.

	Health outcome 1. Self-rated health at later life	Covariates			Early life exposure 5. Childhood health	Social and economic mediators				
		2. Age group	3. Gender	4. Ethnicity		6. Individual education	7. Marital status	8. Urban or rural residence	9. Relative living standard	10. Medical insurance
1. Self-rated health	1									
2. Age group	-0.11***	1								
3. Gender	-0.09***	-0.04***	1							
4. Ethnicity	-0.03***	-0.03***	0.02***	1						
5. Childhood health	0.03***	-0.01*	-0.02**	0.04**	1					
6. Individual education	0.15***	-0.26***	-0.26***	-0.02***	0.04**	1				
7. Marital status	-0.04*	0.20**	0.10***	0.02**	-0.01***	-0.14***	1			
8. Urban/rural residence	0.10***	-0.00	0.02	-0.05***	0.05***	0.22***	-0.02***	1		
9. Relative living standard	-0.13***	-0.02*	0.04***	0.00**	-0.04**	-0.15***	0.05	-0.15***	1	
10. Medical insurance	-0.07***	-0.07***	0.05***	0.02	-0.03	-0.23***	0.05**	-0.33***	0.16***	1

Note: Author’s own estimation using CHARLS 2013 data.
 *** if $p < 0.01$
 ** if $p < 0.05$ and $p > = 0.01$
 * if $p < 0.10$ and $p > = 0.05$

3. Results

The results are based on the 18169 completed respondents aged 45 years and over from CHARLS 2013. Table 1 presents the sample size and population characteristics by age and gender. Among our study

population, about 51% were aged 45 to 59 years, 38% aged 60 to 74, and 11% aged 75 and over. There were slightly fewer men than women. Only 8% are ethnic minorities. The analyses show that advanced age, being a woman or being an ethnic minority member are significantly and negatively associated with good self-rated health in later life.

Table 3
Life course influences on self-rated good health in later life, CHARLS 2013.
Source: CHARLS 2013

		Model 1	Model 2	Model 3	Model 4	Model 4	
		Coefficient	Coefficient	Coefficient	Coefficient	Top interval	Bottom interval
Covariates	Aged 45–59						
	Aged 60–74	-0.460 ^{***}	-0.362 ^{***}	-0.384 ^{***}	-0.399 ^{***}	-0.495	-0.303
	Aged 75+	-0.679 ^{***}	-0.500 ^{***}	-0.577 ^{***}	-0.587 ^{***}	-0.745	-0.429
	Men (omitted)						
	Women	-0.417 ^{***}	-0.291 ^{***}	-0.337 ^{***}	-0.034 ^{***}	-0.436	-0.238
	Han majority (omitted)						
	The minorities	-0.312 ^{***}	-0.288 ^{***}	-0.236 ^{***}	-0.229 ^{***}	-0.373	-0.086
Early life health	Perceived health before age 16	0.132^{**}	0.117[*]	0.081	0.073	-0.027	0.173
Middle life SES	Individual educational attainment						
	(1) Under primary schooling (omitted)						
	(2) Second schooling without degree		0.437 ^{***}	0.275 ^{***}	0.264 ^{***}	0.157	0.370
	(3) College and above degree		1.478 ^{***}	0.915 ^{***}	0.736 ^{***}	0.326	1.145
Later life social and economic resources	(1) Married with spouse present (omitted)						
	(2) Married with spouse away			0.151	0.171	-0.038	0.380
	(3) Separated/Divorced/Widowed			0.002	0.022	-0.107	0.151
	(4) Never married			-0.712 ^{***}	-0.697 ^{***}	-1.116	-0.279
	(1) Rural residents (omitted)						
	(2) Urban residents			0.314 ^{***}	0.307 ^{***}	0.197	0.416
	(1) Relatively better living standard (omitted)						
	(2) About the average living standard			-0.346 ^{**}	-0.368 ^{**}	-0.692	-0.043
	(3) Relatively worse living standard			-0.916 ^{***}	-0.862 ^{***}	-1.173	-0.551
	(4) Not reported			-0.764			
	(1) Government insurance (omitted)						
	(2) Urban employee insurance			-0.164	-0.153	-0.614	0.308
	(3) Urban resident insurance			-0.374	-0.347	-0.878	0.184
	(4) New rural cooperative insurance			-0.395 [*]	-0.391 [*]	-0.841	0.059
(5) Commercial insurance			-0.08	0.033	-0.511	0.577	
(6) Other insurance			-0.347	-0.337	-0.832	0.159	
(7) No medical insurance			-0.424 [*]	-0.401 [*]	-0.888	0.086	
Constant		1.411	1.052	2.202	2.204	1.642	2.767
Sample		16824	16824	16824	16824		
Pseudo R-square		0.020	0.030	0.047	0.047		
Akaike information criterion (AIC)		26117	25963	25784	25724		

Notes: (1) Significance level: (2) Age, gender and ethnicity are used as control variables in all models. (3) Model 1: Early-life health; Model 2: Model 1 + mid-life SES. Model 3: Model 2 + later Life social and economic resources. Model 4: Model 3 while using imputed value of relative living standard. (4) Weights are used for all the models. (5) AIC = (2*K-2*LL)/n, in which, LL is the likelihood, K is the number of predictors, n is the number of observations.

* if p < 0.10 and p > =0.05.

** if p < 0.05 and p > =0.01;

*** if p < 0.01;

Overall, 73% of respondents reported currently having good or above health and about 76% of respondents reported good or above childhood health before age 16. There are significant variations in both later life and childhood health by gender and cohort but the variation is larger in later life than in childhood. The proportion with good childhood health was significantly lower for the cohort aged 60–74 years reflecting possible adverse impact of the Great China Famine during 1959-61 (Chen & Zhou, 2007), while higher for those aged 75 and over, probably due to survival effects earlier during periods of war and famine as well as during advancing age.

Among the respondents, 2.2% have college or above degree, 53% have completed primary or secondary school and 44.8% were illiterate or under primary school. Men and the younger cohorts were better educated than women and older cohorts. There was a historic advance in educational attainment after the liberalization as evidenced by the sharp decrease in the proportion being illiterate or under primary school (from 76% for those aged 75 and plus to 32% for those aged 45–59).

At the time of survey, around two thirds (68%) rated their relative living standard as lower, one fourth (28%) about the same and only 4% higher than the average in their same cities or counties. The vast majority of the respondents were covered by at least one type of insurance

scheme: 13% by government or urban employee basic medical insurance, 5% by urban resident medical insurance, 72% by the new rural cooperative medical insurance, and 6% by private or other type of health insurance. There are still 4% without any medical insurance. About 41% of respondents were living in urban areas. The majority (79%) were married with a spouse present and only 1% never married. The proportion of older people aged 75 and over currently without a partner is high (53%).

The Spearman's Rank Correlations in Table 2 is used to examine whether the outcome, exposure, mediators and covariates in our study have significant associations to each other. It suggests that the majority of health, social and economic variables at different life stages are significantly correlated to each other. Childhood health could enable individuals to attain better education, and higher adulthood social, economic and health resources that are more directly related to their later life health.

Variance inflation factors (VIFs) measure how much the variance of the estimated regression coefficients are inflated as compared to when the predictors are not linearly related. It has been used to describe how much multicollinearity (correlation between predictors) exists in a regression analysis.

Table 4
Decomposition of the influences on later life health by gender and exposure-mediator interaction.
Source: Results from KHB method used on CHARLS 2013 data

Influence of childhood health on later life health through socio-economic mediators	Without interaction term				With interaction term			
	All	Men	Women	Gender difference	All	Men	Women	Gender difference
Coefficients in reduced model	0.134*	0.161*	0.112*		0.139*	0.161*	0.112*	
Coefficients in full model	0.073	0.069	0.071		0.048	0.019	0.064	
Difference in the estimated coefficients	0.061*	0.092*	0.041		0.090*	0.142*	0.047	
Total indirect influence	45.53%*	57.15%*	36.60%*	*	65.18%*	88.06%*	42.40%*	*
Education	7.29%*	6.85%*	8.87%*		6.21%*	6.85%*	8.87%*	
In which: Second schooling without degree	8.84%*	4.97%*	13.13%*		7.52%*	4.97%*	13.13%*	
Marital status	5.95%*	15.46%*	-0.16%	*	6.35%*	15.46%*	-0.16%	*
In which: Single	6.04%*	11.21%*	-0.30%	*	5.94%*	11.21%*	-0.30%	*
Urban residence	10.76%*	11.04%*	6.38%*		10.64%*	11.04%*	6.38%*	
Relative living standard	15.05%*	15.65%*	14.20%*		16.67%*	14.74%*	15.67%*	
Interaction between childhood health & living standard					18.70%*	31.82%*	4.33%	*
Medical insurance	6.48%	8.15%	7.31%		6.61%	8.15%	7.31%	

Note: (1) Imputed values for missing information of living standard is used; (2) (3) As the KHB command in STATA 13.1 cannot deal with the exposure-mediator interaction automatically, Author Gong has calculated the influence of interaction term based on the estimated coefficients from the regression models and the formula provided in Valeri and VanderWeele (2013).

* Indicates significance at 10% or P-value < 0.10.

In our study, we estimate Variance Inflation Factors (VIF) from the Ordinary Least-Squares (OLS) regression model of later life self-reported health on all the predictors (exposure, mediators and covariates). They are found to be greater than one, ranking from the highest 17.3 to the lowest 1.0, in which the new rural cooperative medical insurance scheme has a VIF value of 17.4 while other predictors have VIF values all below ten. This indicates that multicollinearity could be an issue for this variable, such as possible instability of its coefficient.

In Table 3, both Pseudo R-square and Akaike information criterion (AIC) are reported for the logistic models, showing that the model goodness of fit improves gradually from 0.02 to 0.05 after more life span social determinants are controlled for successively. In general, a Pseudo R-square value within 0.2 to 0.4 represents excellent fit. The Pseudo R-square in our final model is 0.05, less than the level of excellent fit, but it will still serve for our purpose to investigate how the major social and economic variations during adulthood could mediate the impact of childhood health on later life health. The relatively low level of model fit could be due to other factors, which are not included in this study, but have influence on later life health, such as healthy diet, stress, pollution, family history of diseases, advancement in medical treatment, health care utilization, and public health investment. These topics are beyond the scope of our study but have been addressed as important factors influencing health by several studies (Hu et al., 2011; Wen & Gu, 2011; Smith, Strauss & Zhao, 2014; Xu, Hall, Byles & Shi, 2016).

The multivariate regression results show that the three covariates (advanced ages, women and the ethnical minority) are significantly and negatively associated with good later life health. While childhood health is significantly and positively associated with good later life health (Models 1) indicating that having good childhood health improves the likelihood of good later life health. Individual educational attainment is also significantly and positively associated with good later life health (Model 2). Among current social and economic resources, urban residence and second schooling or above educational attainment are positively associated with good later life health while never being married, reporting a perceived average or worse living standard, having new rural cooperative insurance or no medical insurance are negatively associated with good later life health (Model 3). In Model 4, we use the imputed value of relative living standard for those who did not report this information, and found very similar estimations as those in Model 3 where one category of “Not reported” is used. Due to the limitation of space, we only report the confidence intervals for Model 4 in Table 3.

The changes in the estimated coefficients from Model 1 to Model 3,

suggest that favourable social and economic conditions in adulthood could compensate for the impact of poor childhood health on later life health, given that the estimated coefficients of childhood health become smaller but still significant in Model 2 while much smaller and not significant in Model 3. From this difference method analysis, it seems that the impact of childhood health could be significantly and partially mediated after controlling for adulthood social and economic positions and resources (Model 3). For linear regression models, the decomposition is done by comparing the estimated coefficient of a key variable of interest between a reduced model without control variables and a full model with one or more control variables added. However, for non-linear probability models, decomposing the total effect into direct and indirect one is not straightforward. The KHB-method is developed to solve this problem by providing unbiased decompositions and analytically derived statistical tests for both linear regressions and non-linear probability models, with either discrete or continuous variables (Karlson, Holm & Breen, 2011; Breen et al., 2013).

We check for possible exposure-mediator interactions by running (1) the logistic model of childhood health on all the mediators and covariates, and (2) Model 4 controlling for the interactions of childhood health with each of the mediators separately. Childhood health significantly interacted only with relative living standard, indicating that for those who have had poor childhood health, relative living standard might contribute even more to their later life health, which further confirms the importance of early life experiences and their pathways to later life.

In the next section, we will report the decomposed direct and indirect influences by gender applying controls for the exposure-mediator interactions. The relative living standard with imputed values and KHB method are used for our final analysis in Table 4.

The first three rows of Table 4 report the estimated coefficients of childhood health from the reduced and full models, and other rows provide the decomposition of direct and indirect influences by gender with and without controls for the exposure-mediator interaction. The estimated coefficients of childhood health in the reduced model (before controlling for the mediators) are significant for both genders, but relatively larger for men than for women, while they become insignificant and smaller in the full models (after controlling for the mediators), indicating the strong mediation, especially for men.

The indirect influence of childhood health on later life health mediated by adulthood social and economic position and resources is estimated at 45.53% for the whole sample before controlling for the exposure-mediator interactions. This indirect influence is contributed most

by relative living standard (15.05%) and urban residence (10.76%), followed by medical insurance schemes (6.48%), marital status (5.95%) and education (7.29%). When we use the variable “relative living standard” with a category of “Not reported”, the indirect influence becomes 42.77%, with a difference of 6.5%, showing reasonable robustness in terms of missing information for this key variable.¹⁰

The decomposition analysis by gender shows that the indirect influence is larger for men (57.15%) when compared to women (36.60%), indicating that adulthood social and economic positions and resources have a larger mediation impact on later life health for men than women. Relative living standard, marital status and urban residence are the most significant and important social and economic mediators for men while living standard and secondary schooling are most influential for women. Marital status is not a significant influence for women. The influence of medical insurance scheme becomes insignificant for both genders, probably due to the high multicollinearity between rural cooperative medical insurance and rural residence.¹¹

The last four columns in Table 4 report the KHB results with controls for the interaction term of childhood health with relative living standard. A large and significant influence of this interaction term is found for men, while it is small and not significant for women, indicating that relative living standard can contribute even more to the late life health of men with poor childhood health.

4. Discussion and conclusion

This paper reports on the influence of childhood health on later life health and how this influence could be mediated by social and economic positions and resources in the subsequent life stages among the current cohort of ageing people in China. The analysis focuses primarily on the global measure of self-rated health based on the retrospective life history data for people aged 45 years and over from the 2013 CHARLS survey. About half of the CHARLS sample were aged 45 to 59 years in 2013, having been born during the “Great Leap Forward” from the mid-1950s to mid-1960s, and entering and living adult years from the relatively more prosperous 1980s onwards. Only 10% were very old survivors at ages 75 and over having had childhoods during the privations of the WWII era and its aftermath, and then early adulthoods during the turmoil of the Cultural Revolution from the mid-1960s to the mid-1970s.

The current cohort of ageing Chinese have been exposed to tremendous social and economic change including wars, famine, revolutions, marketization, increasing education attainment, and rising income and health inequalities. Understanding the influence of these health and socioeconomic variations and their accumulating effects through the life course is important in considering policy actions conducive to lifelong good health and quality of life in China, and other similar emerging and middle income countries.

Three-fourths of the ageing respondents in CHARLS reported good or very good self-rated health, with significant differences across the age groups. While childhood health has important influences on later life health, as has been reported earlier by Smith et al. (2012), we report that these early influences lose significance after taking subsequent life experiences into our final explanatory model. The modelling provides further evidence that childhood health is influential for later life health mainly because it enables better access to more proximal social determinants of health - educational attainment, migration to urban areas, higher relative living standards and access to relatively advanced medical insurance schemes, - which are more directly associated with health in later life. The findings further suggest that each of these areas

of social improvement in China over recent decades have contributed to improving health among ageing Chinese. The findings contribute life course understandings of health patterns among ageing Chinese as reported in previous studies (Wen & Gu, 2011; Shen & Zeng, 2014).

Our analyses also show that the social and economic effects on individuals’ health across the life span are overlaid by systematic differences between social groups in terms of gender, ethnicity, marital status, and area of residence. The more limited life opportunities afforded to women, non-Han minorities, people who never married and rural residents have repercussions as observed in their relatively poor self-rated health. Never being married is significantly associated with later life poor health even after controlling for early life health for men, but not for women. This gender variation is consistent with the western literature where unmarried men have been found to have relatively poor health while women’s health is less related to their marital history (Kendig, Dykstra, Van Gaalen & Melkas, 2007). These findings indicate priority target groups for action on the social determinants of health.

The KHB method employed in our study provides unbiased decomposition of the direct and indirect influences on later life health. Gender difference has also been explored. The new findings from this decomposition analysis show that the effects of childhood health are attributable approximately half to direct effects and another half to indirect influences on later life health. These effects are greater for men than women.

The most significant and important social and economic mediators for men include relative living standard, marital status and urban residence; while for women they are relative living standard and secondary schooling. The relative living standard is even more important for men who have had poor childhood health. A plausible explanation could be that men in China are still the main earners in most of the families, especially in rural areas, so that their poor childhood health matters greatly to their relative living standard in adulthood and hence their accumulating influences on lifelong health.

These findings are grounded in the Chinese social, cultural and development context. Firstly, adulthood social and economic positions and resources, especially marital status, have relatively larger impacts on later life health for men than women. This may reflect the possible influence of traditional Asian culture on gender roles where men are more likely to dominate in economic and public life while women are more likely to dominate in the family; In addition, women are more capable in self-managing their health than men (Gong et al., 2016). Secondly, notwithstanding rapid change especially for the younger age groups, the majority of ageing people continue to live in rural areas as farmers. Urban residence benefits health primarily through better access to social, economic and health resources. Thirdly, relative living standards (instead of household expenditure) is a significant mediator underpinning good later life health. This reflects the health impact of subjective hardship and the variable purchasing power of income across regions in China. Finally, unequal access to health services use is indicated by the importance of medical insurance scheme as a significant impacts on later life health. This supports the case for health care reform with universal access to basic medical insurance in China.

Our findings suggest that investment in childhood health can have life-long benefits as they strengthen capacities for further development into adulthood. Further, these childhood influences are subject to accumulations of additional experiences for better or for worse, suggesting the value of ongoing socio-economic security in supporting positive health outcomes. The systematically poorer health outcomes for women, ethnic minorities, and those in rural areas suggest target groups for action that would address social, economic and health inequalities (WHO, 2008). Our findings have implications for public policy in meeting the WHO global directions towards improving health status and reducing morbidity and mortality in middle-income and developing countries (WHO, 2008, 2015; Yiengprugsawan, Healy & Kendig, 2016).

In assessing the findings, it is important to take into account possible bias in recall of earlier life experiences as well as selective survivor

¹⁰ Wen and Gu (2011) found a 5% difference before and after Multiple Imputation (MI) for the missing information based on other survey.

¹¹ The high multicollinearity could generate the instability of the estimated coefficients as discussed above on VIF values.

effects especially at older ages. It also needs to be acknowledged that this cross-sectional data from one round of CHARLS has limited capacity for investigating the differential impacts of age and cohort, and it is not possible to adequately address issues of confounding or endogeneity in inferring causal relationships (Valeri & VanderWeele, 2013).

Further analyses of the CHARLS longitudinal data can address issues of causality and identify health and other changes as people grow older and experience transitions such as retirement, bereavement, and the onset of disease and disability. Further rounds of CHARLS can shed light on social processes clarifying the life course influences of individual aging, cohort succession, and emergent periods of history, as well as underlying social variation on divergent health outcomes in later life.

The life span findings reported here have mixed implications for the future of aging and health issues in China. On the one hand, projected increases in demographic aging will increase the numbers of older people at advanced ages where chronic disease and frailty are more prevalent. On the other hand, the earlier cohorts whose life-long health was damaged by early life poverty and famine are being succeeded by more recent age cohorts that have been advantaged by the significant economic advancement since the mid-1980s. Over the longer term, continuing rises in living standards and improved childhood health should increase health and capacities over the life span in China.

Ethics approval

The original CHARLS was approved by the Ethical Review Committee of Peking University, and all participants signed informed consent at the time of participation.

References

- Ben-Shlomo, Y., Cooper, R., & Kuh, D. (2016). The last two decades of life course epidemiology, and its relevance for research on ageing. *The International Journal of Epidemiology*, 45(4), 973–988.
- Breen, R., Karlson, K. B., & Holm, A. (2013). Total, direct and indirect effects in logit and probit models. *Sociological Methods Research*, 42(2), 164–191.
- Cai, J., Coyte, P., & Zhao, H. (2017). Determinants and socio-economic disparities in self-rated health in China. *International Journal for Equity in Health*, 16(1), 7. <http://dx.doi.org/10.1186/s12939-016-0496-4>.
- Chen, Y., & Zhou, L. (2007). The Long term health and economic consequences of the 1959–1961 Famine in China. *Journal of Health Economics*, 659–681.
- Dannefer, D. (2003). Cumulative advantage/disadvantage and the life course: Cross-fertilizing age and social science theory. *The Journal of Gerontology Series B, Psychological Sciences and Social Sciences*, 58(6), S327–S337.
- Dannefer, D., & Kelley-Moore, J. (2009). Theorizing the life course: New twists in the paths. In V. Bengtson, D. Gans, N. Putney, & M. Silverstein (Eds.). *Handbook of theories of aging*. New York, NY: Springer Publishing Company, LLC.
- French, D. J., Browning, C., Kendig, H., Luszc, M. A., Saito, Y., Sargent-Cox, K., & Anstey, K. J. (2012). A simple measure with complex determinants: Investigation of the correlates of self-rated health in older men and women from three continents. *BMC Public Health*, 12, 649.
- Gibson, G. (1972). Chinese medical practice and the thoughts of Chairman Mao. *Social Science & Medicine*, 6(1), 67–93.
- Gong, C., Leigh, A., & Meng, X. (2012). Intergenerational income mobility in urban China. *Review of Income and Wealth*, 58(3), 481–503.
- Gong, C. H., Kendig, H., & He, X. (2016). Factors predicting health services use among older people in China: An analysis of the China Health and Retirement Longitudinal Study 2013. *BMC Health Services Research*, 16, 63.
- Hertzman, C., Power, C., Matthews, S., & Manor, O. (2001). Using an interactive framework of society and lifecourse to explain self-rated health in early adulthood. *Social Science & Medicine*, 53(12), 1575–1585.
- Hu, F. B., Liu, Y., & Willett, W. C. (2011). Preventing chronic diseases by promoting healthy diet and lifestyle: Public policy implications for China. *Obesity Reviews*, 12, 552–559.
- Lei, X., Sun, X., Strauss, J., Zhao, Y., Yang, G., Hu, P., Hu, Y., & Yin, X. (2014). Health outcomes and socio-economic status among the mid-aged and elderly in China: Evidence from the CHARLS national baseline data. *The Journal of the Economics of Ageing*, 2014(3), 29–43.
- Karlson, K. B., Holm, A., & Breen, R. (2011). Comparing regression coefficients between models using logit and probit: A new method. *Sociological Methodology*, 42, 286–313.
- Kendig, H., Dykstra, P. A., Van Gaalen, R., & Melkas, T. (2007). Health of ageing parents and childless individuals. *Journal of Family Issues*, 28(11), 1457–1486.
- Kendig, H., & Nazroo, J. (2016). Life course influences on inequalities in later life: Comparative perspectives. *Journal of Population Ageing*, 9(1), 1–7.
- Kohler, U., Karlson, K. B., & Holm, A. (2011). Comparing coefficients of nested nonlinear probability models. *The Stata Journal*, 11, 420–438.
- Li, X., & Zhang, W. (2013). The impacts of health insurance on health care utilization among the older people in China. *Social Science Medicine*, 85(2013), 59–65.
- Richiardi, L., Bellocco, R., & Zugna, D. (2013). Mediation analysis in epidemiology: Methods, interpretation and bias. *International Journal of Epidemiology*, 2013(42), 1511–1519.
- Shen, K., & Zeng, Y. (2014). Direct and indirect effects of childhood conditions on survival and health among male and female elderly in China. *Social Science & Medicine*, 119, 207–214.
- Smith, J. P., Shen, Y., Strauss, J., Zhe, Y., & Zhao, Y. (2012). The effects of childhood health on adult health and SES in China. *Economic Development and Cultural Change*, 61(1), 127–156.
- Smith, J. P., Strauss, J., & Zhao, Y. (2014). Healthy aging in China. *The Journal of the Economics of Ageing*, 4, 37–43. <http://dx.doi.org/10.1016/j.jeoa.2014.08.006>.
- United Nations (2013). *World Population Ageing 2013*. New York: Department of Economic and Social Affairs, Population Division United Nations 2013. <http://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2013.pdf>.
- Valeri, L., & VanderWeele, T. J. (2013). Mediation analysis allowing for exposure–mediator interactions and causal interpretation: Theoretical assumptions and implementation with SAS and SPSS Macros. *Psychological Methods*, 18(2), 137–150.
- Wen, M., & Gu, D. (2011). The effects of childhood, adult, and community socioeconomic conditions on health and mortality among older adults in China. *Demography*, 48(1), 153–181.
- WHO (2008). *Closing the gap in a generation: Health equity through action on the social determinants of health*. Geneva: The World Health Organization and Commission on Social Determinants of Health.
- WHO (2015). *World report on ageing and health*. Geneva: World Health Organization.
- World Bank (2014). *East Asia Pacific at work: Employment, enterprise, and well-being*. Washington DC: International Bank for Reconstruction and Development.
- Xie, Y., & Zhou, X. (2014). Income inequality in today's China. *Proceedings of the National Academy of Sciences of the United States of America*, 111(19), 6928–6933.
- Xu X.; Hall J., Byles J., & Shi Z. (2016). Dietary Pattern, Serum Magnesium, Ferritin, C-Reactive Protein and Anaemia among Older People. *Clinical Nutrition*. Available online 25 December 2015. <http://dx.doi.org/10.1016/j.clnu.2015.12.015>.
- Xu, X., Shi, S., & Huang, Q. (2014). The Chinese urban rural dual economic structure model and analysis. *Asian Agriculture Research* 2014, 6(1), 18–23.
- Wang, X., & Zheng, C. (2014). The impact of health insurance on medical expenditure and health of the elderly. *Journal of Finance and Economics*, 12, 006.
- Yeatts, D. E., Pei, X., Cready, C. M., Shen, Y., Luo, H., & Tan, J. (2013). Village characteristics and health of rural Chinese older adults: Examining the CHARLS Pilot Study of a rich and poor province. *Social Science & Medicine*, 98, 71–78.
- Yiengprugsawan, V., Healy J., and Kendig H. (2016). Comparative country studies on health system responses to population ageing and noncommunicable diseases in Asia. WHO Regional Office for South-East Asia, Delhi: World Health Organization on behalf of the Asia Pacific Observatory on Health Systems and Policies.
- Yip, W., Subramanian, S. V., Mitchell, A. D., Lee, D. T., Wang, J., & Kawachi, I. (2007). Does social capital enhance health and well-being? Evidence from rural China. *Social Science & Medicine*, 64(1), 35–49.
- Zeng, Y., Gu, D., & Land, K. C. (2007). The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. *Demography*, 44, 497e518. <http://dx.doi.org/10.1353/dem.2007.0033>.
- Zhao, Y., Hu, Y., Smith, J. P., Strauss, J., & Yang, G. (2014). Cohort profile: The China Health and Retirement Longitudinal Study (CHARLS). *The International Journal of Epidemiology*, 43(1), 61–68.
- Zhao, Y., Smith, J. P., & Strauss, J. (2014). Can China age healthily? *Lancet*, 384(9945), 723–724.