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ARTICLE

Association between childhood conditions and arthritis among middle-aged and older adults in China: the China Health and Retirement Longitudinal Study

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Abstract

This study examined the association between childhood conditions and arthritis among middle-aged and older adults in China. The data were derived from the 2015 wave and the life-history module of the China Health and Retirement Longitudinal Study. Face-to-face interviews were conducted with respondents age 45 and over across China. Multiple imputation was used to handle the missing data, generating a final analytic sample of 19,800. Doctor-diagnosed arthritis was the main outcome variable. Random-effects logistic regression models were used to test the proposed models. Approximately 8 per cent of the respondents had better family financial status in childhood than their neighbours. Close to 8 per cent had been hospitalised or encountered similar conditions (*e.g.* confined to bed or home) for at least one month in childhood. Around one-third reported better subjective health in childhood than their peers. The majority of the respondents (80%) reported that they had stable health resources, and that their mothers were illiterate during their childhood. Childhood family financial status, subjective health, mother's education, access to health care and medical catastrophic events were found to be significant factors associated with arthritis in later life, after controlling for adulthood and older-age conditions (family financial status: odds ratio (OR) = 0.885, 95 per cent confidence interval (95% CI) = 0.848–0.924; subjective health: OR = 0.924, 95% CI = 0.889–0.960; mother's education: OR = 0.863, 95% CI = 0.750–0.992; access to health care: OR = 0.729, 95% CI = 0.552–0.964; medical catastrophic events: OR = 1.266, 95% CI = 1.108–1.446). The study results highlight an important role that childhood conditions play in affecting the onset of arthritis in late life in China. Health-care providers may consider childhood conditions as a valuable screening criterion to identify risk populations, which could be used to guide health promotion and prevention programmes, and promote healthy ageing.

Keywords: childhood conditions; arthritis; life course; China Health and Retirement Longitudinal Study (CHARLS)

Introduction

Arthritis refers to a range of diseases of joint inflammation. Arthritis symptoms include joint pains, stiffness, swelling, and reduced range and flexibility of motion. Two most common arthritis types are rheumatoid arthritis and osteoarthritis (Ropes *et al.*, 1959; Zhang *et al.*, 2010). Arthritis is one of the most common causes of functional loss, falls, fractures and years lived with disabilities in older age (Brooks, 2006; Hoy *et al.*, 2014; Speerin *et al.*, 2014; Smith *et al.*, 2016). Musculoskeletal conditions, including arthritis, accounted for around 20 per cent of 'years lived with disability' among older adults living in developing countries (Hoy *et al.*, 2014). Arthritis can happen at all ages, but it occurs more frequently as people get older (Li *et al.*, 2015). For example, nearly one-fifth of the adult population reported that they had doctor-diagnosed arthritis in the United States of America (USA) in 2015 (Barbour *et al.*, 2018). Among older adults age 65 years and older, the prevalence of arthritis is higher in women than in men, 69 per cent *versus* 56 per cent, respectively, in the USA (Jafarzadeh and Felson, 2018).

Arokiasamy *et al.* (2017) found that the prevalence of arthritis was the second most common chronic non-communicable disease in older age in low- and middle-income countries. In particular, approximately one-fifth of the respondents age 50 and older had self-reported arthritis in China. Among those with arthritis, nearly one-third did not receive any treatment (Arokiasamy *et al.*, 2017). Furthermore, another study showed that 31 per cent of Chinese adults age 45 and older reported doctor-diagnosed arthritis (Li *et al.*, 2015).

Arthritis-related pain and functional impairment are not only chronic and stressful for older adults, but may also lead to higher demand for long-term care, further exaggerating caregiver burden in multiple dimensions (Lu, Liu and Lou 2015, 2016; Lu et al. 2017). Arthritis also causes a high level of financial burden to families and the health-care system (Murphy *et al.*, 2018). For example, the total expenditures in medical care and earning losses due to arthritis were around US $303.5 billion in the USA in 2013 (Murphy *et al.*, 2018). Therefore, it is important to study risk factors of arthritis in later life, particularly in China where populations are rapidly ageing. The knowledge generated could inform prevention and treatment of arthritis, reduce health-care costs, and improve quality of life for older adults and their family.

Socio-demographic characteristics, health behaviour, obesity and chronic diseases (*e.g.* hypertension, heart disease and digestive disease) were found to be significant risk factors of arthritis (Blagojevic *et al.*, 2010; Sugiyama *et al.*, 2010; Li *et al.*, 2015; Badley *et al.*, 2017). A study conducted in China suggested that age, gender, physical exercise and cardiovascular disease were associated with arthritis in adulthood and old age (Li *et al.*, 2015). While the current literature focuses on the proximal variables stated above, distal variables such as early-life conditions are largely understudied.

Empirical evidence has consistently shown that early-life conditions play an important role in influencing health outcomes in later life, such as incidences of

chronic diseases, mental health status and mortality. For example, family financial status (FFS) and nutrition in childhood were important predictors of cognitive performance among middle-aged and older adults in China. Childhood health was also found to be associated with cardiovascular diseases in later life in rural China (Wang and Shen, 2016). Furthermore, access to health-care resources and severe illnesses in childhood were important risk factors of functional loss and mortality (Yi *et al.*, 2007). However, there is little knowledge about the relationships between early-life conditions and arthritis, particularly among Chinese populations.

Given a high prevalence rate of arthritis among populations age 45 and older, and the close relationship between arthritis, cardiovascular diseases and functional loss, it is likely that early-life conditions also have a significant impact on arthritis. This study aimed to examine risk factors of arthritis among middle-aged and older populations in China from a lifecourse perspective.

Early-life conditions and arthritis in later life

Childhood conditions could have both direct and indirect effects on arthritis in later life. The underlying mechanisms could be explained by the latency model and pathway model, respectively (Brandt *et al.*, 2012; Haas 2008; Zhang, Gu and Hayward 2010). According to the latency model, childhood health status has direct effects on physical health outcomes in adulthood and older age by influencing its trajectory patterns (Brandt *et al.*, 2012; Zhang, Gu and Hayward 2010). Low FFS, malnutrition and severe illness during childhood could have irreversible effects on the health trajectories over the lifecourse, even after controlling for adulthood conditions. Childhood malnutrition, for example, may lead to lower growth rates of musculoskeletal developments and weakened immune systems (Matkovic *et al.*, 2004; Blanton *et al.*, 2016; Lima *et al.*, 2017). Musculoskeletal and immune systems play important roles in affecting joint inflammation, which leads to arthritis (Ropes *et al.*, 1959; Zhang *et al.*, 2010).

Furthermore, proponents of the pathway model argue that early-life adversity also indirectly affects late-life physical health, through their influences on educational attainments and employment in adulthood (Haas, 2008; Brandt *et al.*, 2012). Poor childhood health has long-term negative impacts on social competence and cognitive performance, which can lead to lower educational attainments and incomes in adulthood (Case *et al.*, 2005; Haas, 2008; Brandt *et al.*, 2012). Childhood health is also an important predictor of chronic diseases in adulthood (*e.g.* hypertension and heart diseases) (Case *et al.*, 2005; Yi *et al.*, 2007; Wang and Shen, 2016). Furthermore, low FFS in childhood and adulthood is associated with poor living conditions and physical environment. Empirical evidence suggests that low FFS, poor living conditions and unhealthy behaviours (*e.g.* smoking, drinking and lack of regular exercise) in adulthood lead to negative health outcomes in old age (Haas, 2008; Brandt *et al.*, 2012). There was also some evidence that physical occupations such as farming were found to be a risk factor of knee pain and osteoarthritis (Blagojevic *et al.*, 2010).

In summary, poor health and low FFS in childhood could have negative relationships with health outcomes in later life, both directly and indirectly. The findings of

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childhood conditions and arthritis in later life have important policy and intervention implications for achieving healthy and active ageing.

Rural–urban disparity: social backgrounds of early-life conditions among Chinese populations

The economic reforms and rapid urbanisation in China were initiated in the late 1970s. Thus, the majority of the current cohort of adults age 45 and older, born before 1970, generally lived in rural communities during their childhood. China is recognised as a two-tier society: rural and urban China. While eastern coastal regions have experienced economic prosperity in the past few decades, rural China, especially in western regions, lags behind both socially and economically (Zhu, 2003). The income gap between urban and rural China has expanded since China's economic reforms in 1978 (2.57 times in 1978 *versus* 3.13 times in 2011) (National Bureau of Statistics of China, 2016). Millions of public expenditures have been invested in the social infrastructure of urban cities. Educational and medical resources are mainly accumulated in urban regions (Guo and Chen, 2009). Furthermore, Chinese citizens with different types of household registration status (*i.e.* non-agricultural *versus* agricultural) are entitled to different levels of educational opportunities and different types of social welfare systems (Fang *et al.*, 2009). Although Chinese governments have initiated significant reforms and made great progress in developing universal pension and medical insurance systems, the benefits of social welfare systems still vary across rural and urban areas (Cai and Cheng, 2014; Shum *et al.*, 2015; Liu *et al.*, 2016). These factors can have prolonged impacts on both rural and urban residents' health trajectories over the life course; more specially, by affecting their childhood health, educational attainments and job opportunities in adulthood, as well as their living conditions, neighbourhood environment and health service resources across different lifestages. Therefore, household registration status (agricultural *versus* non-agricultural) was considered as a key control variable in the final analysis.

The objective of the study was to examine the associations between childhood conditions and arthritis in later life among the adult population age 45 years and older in China. Based on the above literature and theoretical models, we proposed two sets of hypotheses among Chinese older adults:

(A) This study aimed to examine the association between family conditions in childhood and arthritis in later life. Specifically, two hypotheses were proposed:
  (1) FFS in childhood is associated with arthritis in later life.
  (2) Mother's education level in childhood is associated with arthritis in later life.

(B) This study aimed to examine the association between individuals' health conditions and health-care resources in childhood and arthritis in later life. Specifically, three hypotheses were proposed:
  (1) Childhood subjective health is associated with arthritis in later life.
  (2) Medical catastrophic events in childhood are associated with arthritis in later life.

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(3) Access to health care in childhood is associated with arthritis in later life.

Methods

Sampling

The data were derived from the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is a publicly available data-set using a nationally representative sample of community-dwelling adults age 45 and older in China. A multi-stage cluster sampling method was conducted to recruit respondents. The details of the sampling strategies of CHARLS are available elsewhere (Zhao *et al.*, 2014). Community-dwelling adults aged 45 years and older were eligible to participate the survey. Face-to-face interviews were conducted with eligible respondents from approximately 10,000 households in 28 provinces between 2011 and 2012. The baseline survey was completed by 17,708 respondents (around 80.5% response rate). In total, 18,612 and 21,097 respondents completed the 2013 and 2015 wave of the survey, respectively. Ethical approval was obtained from the Ethical Review Committee of Peking University.

The present study was based on the 2015 wave of the survey. In CHARLS, 20,543 respondents who participated in the 2011 and 2013 waves were invited and completed a new module named the 'life-history survey questionnaire' in 2014. The life-history survey included rich information about each respondent's childhood conditions, relationships with their parents, education history, health history, health-care history, and wealth and work history. In this study, data on childhood conditions were derived from the life-history module. In the 2015 wave, the number of eligible respondents was 19,800. Multiple imputation was conducted to handle the missingness, which allowed us to conduct analysis based on the whole sample (*see* details in the data analysis section).

Measurements

Dependent variable

We used doctor-diagnosed arthritis as the primary outcome in this study. Respondents were asked whether a doctor had ever told them that they had arthritis. The answer was coded by a binary variable (0 = no, 1 = yes).

Childhood conditions

Childhood FFS was assessed by a single question: 'Before age 17, how was your family's financial status as compared with the average levels in the same community/village?' Responses were measured using a five-point Likert scale (0 = a lot worse, 2 = same, 4 = a lot better). Mother's education was recoded into a binary variable (0 = illiterate, 1 = received some formal education or higher). Childhood subjective health was assessed by a single question: 'Before age 15, how did you evaluate your health conditions as compared with your peers?' Answers were assessed by a five-point Likert scale (0 = much less healthy, 2 = about average, 4 = much healthier). Furthermore, respondents were asked whether they had been hospitalised/confined to bed or home/missed school for at least one month before

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age 15. Finally, respondents were asked whether they had access to stable sources of health care within two hours travel during their childhood. Responses to these questions were assessed by binary variables (0 = no, 1 = yes).

Adulthood conditions

For the respondents aged between 45 and 59, the period of adulthood conditions was between the ages of 18 and 44. For those age 60 and older, the period of adulthood conditions was between 18 and 59. Regarding medical catastrophic events, the respondents were asked whether they had been confined to bed/hospitalised/left jobs for at least one month during their adulthood. Respondents' answers were further recoded into a binary variable (0 = no, 1 = yes). We further recoded the responses into a binary variable (0 = non-agricultural jobs, 1 = agricultural jobs). Regarding employment status, respondents were asked to report their jobs that lasted for at least six months. Respondents were also asked whether they had a stable health-care source during their adulthood (0 = no, 1 = yes).

Conditions in later life

For the respondents aged between 45 and 59, the period of later-life conditions started from age 45; for those age 60 and older, the period of later-life conditions started from 60. Household assets were assessed at the respondents' whole household level, including property value and mortgage for the primary house, other real estate, non-financial household assets, vehicles, fixed capital assets, value of livestock and irrigable land. The log value was used to present the level of household assets. Body Mass Index (BMI) was measured as either a continuous variable or a categorical variable (underweight, normal weight, overweight and obesity) in previous studies (Blagojevic *et al.,* 2010). In this study, BMI was calculated by dividing an individual's weight by the square of his or her height. The scores were further recoded as a categorical variable (underweight = lower than 18.5; normal weight = 18.5–24.9; overweight = 25–29.9; obesity = 30 and above). Three dummy variables were recoded and included in the final analysis (with normal weight as the reference group).

Regarding functional limitations, respondents were asked whether they had difficulty conducting any of the following seven tasks: getting up from a chair, climbing stairs, walking 1 kilometre, running 1 kilometre, walking 100 metres, extending arms above shoulder level, and stooping, kneeling or crouching. Respondents were asked whether they had the following doctor-diagnosed chronic diseases: cardiovascular diseases, hypertension, and stomach or other digestive diseases. The answers were recoded as binary variables (0 = no, 1 = yes). The summed scores were used to represent the number of chronic diseases, ranging from 0 to 13. Regarding access to health care, respondents were asked whether they had a stable health-care source in their later life. Responses were recoded as a binary variable (0 = no, 1 = yes).

Covariates

Age was measured by the respondents' age at the time of the 2015 wave's interview. Gender, marital status, household registration status and education were assessed by binary variables (0 = women, 1 = men; 0 = other marital status, 1 = married; 0 = agricultural, 1 = non-agricultural; 0 = illiterate, 1 = receive some formal education

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or higher). The respondents were asked whether they had ever quit smoking, reduced drinking, increased their physical activity and/or changed their diet when they were between 16 and 55 years old. Responses to each question were recoded as a binary variable (0 = no, 1 = yes).

Furthermore, the respondents were asked whether they had ever smoked or had any alcoholic drink in the past year (0 = no or quit smoking/never drink alcoholic beverage, 1 = still smoking/had an alcoholic beverage in the past year). Finally, respondents were asked about the number of days in which they conducted vigorous physical activities for at least ten minutes in a usual week. Vigorous physical activities were defined as activities which need hard/high-intensity physical effort, including cycling with a heavy load, heavy lifting, fast cycling and digging.

Data analysis

Multiple imputation was applied to handle the missing data in the present study by using Chained equations (MICE) in Stata 15.0. MICE does not assume that all the imputed variables have a joint multivariate normal distribution. Instead, MICE conducts a separate conditional distribution for each type of imputed variable. MICE is suitable to impute a binary dependent variable for logistic regressions (Van Buuren, 2007; Lee and Carlin, 2010). The missingness percentages of the dependent variable and childhood conditions ranged from 11.1 per cent for access to health care to 15.5 per cent for mother's education. The highest proportion of missingness was identified in the variable of vigorous physical activity (53.5%). This question was asked among a randomly selected sub-sample of 9,198 respondents. In other words, it was planned missing and met the assumption of 'missing completely at random'. In this case, the relatively large missingness of the variable would not generate estimation problems during the process of multiple imputation.

Besides the early-life, adulthood and later-life variables and dependent variable, we selected a small set of auxiliary variables in the imputed model. The auxiliary variables were not part of the final analytic model, but were correlated with missing variables. They can provide additional information to enhance the quality of imputed scores of key variables in multiple imputation. These variables include socio-demographic factors, functional loss, activities of daily living, cognition, body pain and depressive symptoms. No two selected variables were highly correlated (*i.e.* correlation estimate is 0.7 or closer). Twenty imputed data-sets were generated by using multiple imputation to further perform statistical models using random-effects logistic regression models. The analytic sample size is 19,800.

As discussed previously, the sample was selected from around 10,000 households. Both spouses who met the inclusion criteria might be interviewed. Therefore, random-effects logistic regression models were performed to test the effect of conditions in childhood, adulthood and older age on the onset of arthritis among older adults. The analysis procedures were as follows: first, childhood variables and covariates were entered into the model; second, we regressed the outcome variable on adulthood variables after controlling for childhood variables and covariates; third, variables related to late-life conditions were entered into the model. Stata 15.0 was used to conduct the data analysis. The unweighted analytic results are presented here.

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We conducted several sensitivity analyses as follows. First, a large proportion of the current cohort of adults age 45 and older live in rural areas. Since the majority of medical resources were invested in urban areas, many rural residents do not have access to adequate health-care resources such as hospitals, clinics, doctors and nurses. In this case, many rural adults might have arthritis but have never been diagnosed by health professionals. Since arthritis was assessed by doctor-diagnosed arthritis in this study, the prevalence rate of arthritis might be underestimated. In this case, we used joint pain as a proxy outcome of arthritis and reran the model. Second, we conducted binary logistic regression models and used weights to rerun the data analysis. Third, we reran the data analysis in two age groups (*i.e.* individuals aged between 45 and 59 years and those age 60 years and older). Finally, arthritis is related to some forms of functional limitations in later life. Therefore, we tested the model by excluding the variable on functional limitation. All the sensitivity analyses generated similar results, which are available upon request. The original model is presented below.

Results

Descriptive statistics

Table 1 shows the respondents' characteristics. The mean age of the respondents was 60.2 years. More than 80 per cent of the respondents were married. In 2015, 72.8 per cent had agricultural household registration status and 25.3 per cent were illiterate. Furthermore, 39.6 per cent reported that they had doctor-diagnosed arthritis. Moreover, 8.2 per cent of the respondents considered their childhood FFS was better or a lot better than that of their neighbours. Around one-third of the respondents considered their childhood health to be better than that of their peers. Around 75 per cent reported that their mothers were illiterate during their childhood. Among the respondents, 7.6 per cent had been hospitalised or bedridden due to illness for at least one month during their childhood. This figure was 20.2 per cent in adulthood. Around 8.6 per cent of the respondents did not have stable access to health-care sources during their childhood. This figure decreased over time (7.1% in adulthood and 1.6% in older age). Furthermore, 58.1 per cent of the respondents used to be farmers for at least six months. Less than 10 per cent of the respondents had ever tried to increase their exercise, quit smoking, reduce drinking or change their diets during their adulthood.

Finally, 77.3 per cent of the respondents did not have any functional limitations. Only 8.8 and 21.9 per cent of women were still smoking and had consumed alcohol in the past 12 months, respectively. For men, these figures were 81.0 and 72.2 per cent, respectively.

Results from regression models

Table 2 shows the results of random-effects logistic regression for arthritis. Childhood variables and covariates were regressed on arthritis in Model 1. Respondents with good childhood FFS were less likely to have arthritis (OR = 0.852, 95% CI = 0.816–0.888). Respondents who had good subjective health in

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Table 1. Sample characteristics

	Total sample		Respondents with arthritis (N = 9,065)		Respondents without arthritis (N = 7,839)	
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)
Childhood conditions:						
Poor FFS (worse and a lot worse)	6,933 (35.0)		3,151 (40.2)		2,874 (31.7)	
Not being hospitalised or similar conditions for at least one month	15,958 (80.6)		6,417 (81.9)		7,326 (80.8)	
Good subjective health (healthier and much healthier)	6,161 (31.1)		2,345 (29.9)		2,966 (32.7)	
Had access to health-care sources	15,905 (80.3)		6,339 (80.9)		7,282 (80.3)	
Mother with no educational attainments	14,618 (73.8)		6,244 (79.7)		6,595 (72.8)	
Adulthood conditions:						
Used to be a farmer for at least six months	11,596 (58.1)		5,337 (68.1)		5,274 (58.2)	
Not being hospitalised or similar conditions for at least one month	13,541 (68.4)		5,259 (67.1)		6,348 (70.0)	
Had access to health-care sources	16,197 (81.8)		6,481 (82.7)		7,396 (81.6)	
Later-life conditions:						
Household assets (100 RMB = US $14.2)		5,365.9 (16,548.1)		4,120.0 (14,575.1)		5,574.6 (16,228.1)
BMI:		23.9 (3.9)		23.9 (4.2)		23.8 (3.7)
Underweight (lower than 18.5)			391 (5.0)		428 (4.7)	
Normal weight (18.5–24.9)			3,635 (46.4)		4,188 (46.2)	

Overweight (25–29.9)			1,811 (23.1)		2,117 (23.4)	
Obesity (30 and above)			384 (4.9)		334 (3.7)	
No functional limitation	15,301 (77.3)		5,453 (69.6)		7,668 (84.6)	
Had hypertension	6,129 (31.0)		2,987 (38.1)		2,837 (31.3)	
Had digestive disease	5,666 (28.6)		3,333 (42.5)		2,151 (23.7)	
Had heart disease	3,293 (16.6)		1,798 (22.9)		1,352 (14.9)	
Had access to health-care sources	17,278 (87.3)		6,995 (89.2)		7,839 (86.5)	
Covariates:						
Age:		60.2 (10.2)		62.2 (9.6)		60.4 (9.9)
45–59	9,890 (49.9)		3,196 (40.8)		4,563 (50.3)	
≥60	9,910 (50.1)		4,643 (59.2)		4,502 (49.7)	
Gender:						
Women	10,161 (51.3)		4,511 (57.5)		4,279 (47.2)	
Men	9,639 (48.7)		3,328 (42.5)		4,786 (52.8)	
Marital status:						
Married	17,105 (86.4)		6,544 (83.5)		7,931 (87.5)	
Other marital status	2,694 (13.6)		1,294 (16.5)		1,134 (12.5)	
Education:						
Illiterate	5,010 (25.3)		2,395 (30.6)		2,029 (22.4)	
Some formal education or higher	14,762 (74.6)		5,442 (69.4)		7,036 (77.6)	
Agricultural HRS	14,412 (72.8)		6,099 (77.8)		6,414 (70.8)	

(*Continued*)

Table 1. (*Continued.*)

	Total sample		Respondents with arthritis (N = 9,065)		Respondents without arthritis (N = 7,839)	
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)
Lifestyles in adulthood (16–55 years old):						
Did not increase physical activity	16,056 (81.1)		6,689 (85.3)		7,208 (79.5)	
Did not change diet	16,414 (82.9)		6,756 (86.2)		7,443 (82.1)	
Did not quit smoking	16,576 (83.7)		6,815 (86.9)		7,467 (82.4)	
Did not reduce drinking	16,583 (83.8)		6,826 (87.1)		7,497 (82.7)	
Lifestyles in later life:						
Still smoking	8,703 (44.0)		3,250 (41.5)		4,277 (47.2)	
Drank alcohol in the past year	9,179 (46.4)		3,488 (44.5)		4,289 (47.3)	
No vigorous physical activity	5,993 (30.3)		2,328 (29.7)		2,870 (31.7)	

Notes: N = 19,800. SD: standard deviation. FFS: family financial status. BMI: Body Mass Index. HRS: household registration status. Missingness percentages are as follows: arthritis 14.6%; childhood conditions: childhood FFS 11.9%; mother's education 15.5%; childhood subjective health 12.0%; medical catastrophic events 11.8%; access to health care 11.1%.

Table 2. Random-effects logistic regression for childhood conditions and arthritis

	Model 1				Model 2				Model 3			
	B	SE	OR	95% CI	*B*	SE	OR	95% CI	*B*	SE	OR	95% CI
Childhood conditions:												
Family financial status	−0.161	0.021	0.852*	0.816–0.888	−0.151	0.022	0.860*	0.824–0.897	−0.122	0.022	0.885*	0.848–0.924
Mother's education	−0.168	0.069	0.845*	0.738–0.968	−0.154	0.069	0.857*	0.747–0.982	−0.148	0.071	0.863*	0.750–0.992
Subjective health	−0.111	0.019	0.895*	0.862–0.930	−0.103	0.019	0.902*	0.869–0.937	−0.079	0.020	0.924*	0.889–0.960
Medical catastrophic events	0.320	0.067	1.377*	1.206–1.571	0.272	0.068	1.313*	1.150–1.499	0.236	0.068	1.266*	1.108–1.446
Access to health care	−0.267	0.073	0.766*	0.664–0.884	−0.316	0.142	0.729*	0.551–0.965	−0.316	0.141	0.729*	0.552–0.964
Adulthood conditions:												
Employment status (farmers)					0.265	0.070	1.303*	1.134–1.498	0.228	0.072	1.256*	1.089–1.449
Medical catastrophic events					0.338	0.047	1.402*	1.279–1.538	0.124	0.049	1.133*	1.029–1.247
Access to health care					0.086	0.149	1.089	0.812–1.461	0.179	0.150	1.196	0.889–1.608
Later-life conditions:												
Household assets									−0.012	0.010	0.988	0.970–1.007
BMI (Ref. Normal weight)[1]												
Underweight									−0.179	0.085	0.836*	0.706–0.989
Overweight									0.074	0.054	1.077	0.968–1.197
Obesity									0.324	0.090	1.383*	1.160–1.649
Functional limitations									0.293	0.020	1.341*	1.289–1.395
Hypertension									0.146	0.044	1.157*	1.061–1.261
Digestive disease									0.855	0.042	2.352*	2.164–2.556
Heart disease									0.340	0.055	1.405*	1.262–1.565

(*Continued*)

Table 2. (*Continued.*)

	Model 1				Model 2				Model 3			
	B	SE	OR	95% CI	*B*	SE	OR	95% CI	*B*	SE	OR	95% CI
Access to health care									−0.176	0.164	0.839	0.608–1.156
Covariates:												
Age	0.036	0.003	1.037*	1.031–1.043	0.031	0.003	1.031*	1.025–1.037	0.021	0.003	1.021*	1.015–1.027
Age-squared	−0.002	0.000	0.998*	0.998–0.999	−0.001	0.000	0.999*	0.998–0.999	−0.001	0.000	0.999*	0.998–0.999
Gender	−0.727	0.063	0.483*	0.427–0.548	−0.718	0.063	0.488*	0.430–0.552	−0.549	0.064	0.578*	0.510–0.654
Marital status	−0.172	0.059	0.842*	0.750–0.946	−0.167	0.059	0.846*	0.754–0.950	−0.141	0.059	0.869*	0.773–0.976
Education	−0.026	0.053	0.975	0.879–1.081	−0.002	0.052	0.998	0.901–1.107	0.018	0.053	1.019	0.918–1.130
Household registration status	−0.378	0.055	0.685*	0.616–0.763	−0.271	0.061	0.762*	0.677–0.859	−0.241	0.061	0.785*	0.696–0.886
Lifestyles in adulthood:												
Healthy lifestyle (increase exercise)	−0.095	0.078	0.909	0.780–1.060	−0.080	0.078	0.923	0.791–1.076	−0.045	0.079	0.956	0.818–1.116
Healthy lifestyle (quit smoking)	0.052	0.099	1.053	0.867–1.280	0.031	0.099	1.032	0.848–1.255	0.023	0.098	1.024	0.843–1.242
Healthy lifestyle (reduce drinking)	0.114	0.093	1.121	0.934–1.346	0.092	0.093	1.096	0.912–1.317	0.010	0.095	1.010	0.839–1.218
Healthy lifestyle (change diet)	0.172	0.085	1.188*	1.004–1.405	0.154	0.085	1.166	0.987–1.379	0.100	0.085	1.105	0.934–1.307
Smoke in later life	0.092	0.058	1.096	0.978–1.229	0.086	0.058	1.090	0.973–1.221	0.042	0.058	1.043	0.930–1.170
Drink in later life	0.167	0.046	1.182*	1.080–1.293	0.171	0.045	1.187*	1.086–1.297	0.153	0.046	1.165*	1.065–1.274
Vigorous physical activity in later life	0.050	0.011	1.052*	1.028–1.076	0.050	0.011	1.051*	1.028–1.075	0.062	0.011	1.064*	1.040–1.088

Notes: SE: standard error. OR: odds ratio. CI: confidence interval. Ref.: reference group. 1. Underweight = <18.5; normal weight = 18.5–24.9; overweight = 25–29.9; obesity = 30 and above.
Significance level: * $p < 0.05$.

childhood and whose mothers had some educational attainments were also less likely to have arthritis (subjective health: OR = 0.895, 95% CI = 0.862–0.930; mother's education: OR = 0.845, 95% CI = 0.738–0.968). Medical catastrophic events and access to stable health-care sources were significantly associated with arthritis (medical catastrophic events: OR = 1.377, 95% CI = 1.206–1.571; access to health care: OR = 0.766, 95% CI = 0.664–0.884).

Adulthood variables were entered into Model 2. All childhood variables remained significant. Regarding adulthood variables, respondents who used to be farmers for at least six months were 1.303 times more likely to have arthritis, as compared to their counterparts (OR = 1.303, 95% CI = 1.134–1.498). Having medical catastrophic events increased the likelihood of arthritis (OR = 1.402, 95% CI = 1.279–1.538).

Variables related to late-life conditions were entered in Model 3. All childhood variables remained significantly associated with arthritis. Being farmers and medical catastrophic events in adulthood were still significantly associated with arthritis (being farmers: OR = 1.256, 95% CI = 1.089–1.449; medical catastrophic events: OR = 1.133, 95% CI = 1.029–1.247). Respondents who had functional limitations and those with chronic diseases in older age were more likely to have arthritis (functional limitations: OR = 1.341, 95% CI = 1.289–1.395; hypertension: OR = 1.157, 95% CI = 1.061–1.261; digestive disease: OR = 2.352, 95% CI = 2.164–2.556; heart disease: OR = 1.405, 95% CI = 1.262–1.565). Obese respondents were more likely to have arthritis than those of normal weight (OR = 1.383, 95% CI = 1.160–1.649).

Discussion

In this study, we investigated arthritis in older age from a life course perspective. Based on a nationally representative survey, we tested the associations between early-life conditions and arthritis among middle-aged and older adults in China. The findings highlight the crucial role of childhood FFS and health status that is related to arthritis among Chinese populations.

Consistent with the findings of previous studies (Haas, 2008; Blagojevic *et al.*, 2010; Sugiyama *et al.*, 2010; Brandt *et al.*, 2012; Li *et al.*, 2015; Badley *et al.*, 2017), the findings of this study show that older age, being female, being married, obesity, hypertension, digestive disease, heart disease, unhealthy behaviours (*e.g.* drinking) and vigorous physical activity in later life were significantly associated with the onset of arthritis in later life. This study added new empirical evidence, suggesting that childhood conditions and physical occupation and medical catastrophic events in adulthood play important roles in affecting the onset of arthritis in later life.

Specifically, childhood FFS, mother's education, health conditions and access to health-care resources remained significant determinants of arthritis in later life from Model 1 to Model 3. The findings supported the latency model, which suggested that childhood conditions had direct impacts on health outcomes in late life. Furthermore, the effect sizes of childhood variables were decreased when adulthood and older-age variables were entered into the model. This indicates that the above associations could be partially explained through the impacts of the childhood

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variables on adulthood and later-life conditions. The role of medical catastrophic events in adulthood on arthritis could also be explained through its influence on physical health outcomes in later life. Our findings, therefore, also supported the pathway model, which suggested that early-life conditions have indirect impacts on health outcomes in later life through their influences on later-life conditions.

This study has several important policy and intervention implications. First, childhood FFS, health, mother's education, and adulthood occupation and medical catastrophic events should be used as screening tools to identify risk populations. Given the significant contribution that arthritis made to years lived with disability, policy makers should encourage prevention and educational training among risk populations in their earlier lifestages, especially for those with poor childhood conditions. Maintaining a healthy weight, choosing a healthy diet and regular exercise, for example, can be useful strategies. Second, while unhealthy behaviours (*e.g.* drinking), obesity and chronic diseases (*e.g.* heart disease and hypertension) were recognised as important determinants of the onset of arthritis (Haas, 2008; Blagojevic *et al.*, 2010; Sugiyama *et al.*, 2010; Brandt *et al.*, 2012; Li *et al.*, 2015; Badley *et al.*, 2017), we should develop prevention strategies from a life course perspective. In other words, prevention interventions around risk populations should not only focus on childhood conditions, but also some key factors in adulthood (*e.g.* adulthood medical catastrophic events and types of occupation). Specifically, researchers should pay particular attention to older adults with poor childhood conditions and those involved in physical occupations such as farming in adulthood. Their physical health conditions such as arthritis diagnosis and joint health, and corresponding social needs, should be further examined in needs assessments. Finally, educational and prevention programmes for health management, chronic diseases and care-giver support programmes should be conducted among older patients with arthritis.

Despite its merits, the present study has several limitations. First, data on childhood conditions are retrospective in nature. Future longitudinal studies are needed to collect more accurate and objective data. Second, genetic factors and family health history information were not included in the CHARLS questionnaires. Therefore, we cannot control these important factors in the final model. Third, the self-reported nature of the data may result in inaccuracy and misclassification bias. Fourth, rural residents have limited access to health-care services and professionals. Therefore, the prevalence rates of arthritis among rural populations might be underestimated. In this case, the association between early-life conditions and arthritis tended to be underestimated. We also did further analysis by using joint pains in the final model. The results were similar. Finally, we did not examine the role of transition in household registration status in influencing arthritis in later life. Future studies are needed to examine further the effects of the changes in household registration status on health among older populations.

Conclusion

This study investigated the impact of individuals' health conditions, access to health care resources, FFS and mother's education level in childhood on the onset of arthritis in later life. The findings suggest that all the childhood variables described

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above are significant risk factors of arthritis in later life in China. Health-care professionals may consider using early-life conditions as screening criteria to identify risk populations in communities. While the concept of prevention becomes increasingly important, prevention interventions should be implemented from a life course perspective. Physical health conditions and social needs among older adults with poor childhood conditions and those involved in physical occupations should be paid attention in comprehensive geriatric assessment, health management programmes and care-giver support programmes.

Data. This analysis is based on the 2014 and 2015 waves of the China Health and Retirement Longitudinal Study (CHARLS). The analysis uses data or information from the Harmonized CHARLS data-set and Codebook, Version C as of April 2018 developed by the Gateway to Global Aging Data. The development of the Harmonized CHARLS was funded by the National Institute on Ageing (R01 AG030153, RC2 AG036619, R03 AG043052). For more information, *see* www.g2aging.org.

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