Prevalence and Risk Factors of Asthma among People aged 45 and Older in Mainland China: A Cross-sectional Study from CHARLS in 2018

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1 **Prevalence and risk factors of asthma among people**
2 **aged 45 and older in mainland China: a cross-sectional**
3 **study from CHARLS in 2018**

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Abstract

Background: Asthma is one of the most prevalent chronic respiratory disease worldwide. The survey aims to describe the updated prevalence and risk factors of asthma among individuals aged 45 and older in mainland China.

Methods: The data for this study come from the fourth wave of China Health and Retirement Longitudinal Study (CHARLS) conducted by the National School of Development of Peking University in 2018. CHARLS is a nationally representative survey targeting populations aged 45 and over from 28 provinces/cities in mainland China. A representative sample of 19816 participants were recruited for the study using a multi-stage stratified sampling method. The prevalence of asthma was described across different characteristics. The potentially risk factors were examined by multivariable logistic regressions.

Results: A total of 18504 participants (8759 men and 9745 women) were eligible for the final data analysis. The estimated prevalence of asthma among Chinese people age $\geq$ 45 years in 2018 was 2.16% (95%CI 1.96-2.38). The prevalence of asthma significantly differs according to race ($P=0.002$), with an overall rate of 2.06% (95% CI 1.86-2.29) in Han and 3.28% (95%CI 2.47-4.34) in minorities. Furthermore, the minorities (OR=1.54 [95% CI 1.114-2.122], $P=0.009$), elderly people (60-69 years group: OR=2.65 [95% CI 1.230-5.702], $P=0.013$; $\geq$ 70 years group: OR=3.38 [95% CI 1.741-8.036], $P=0.001$), middle-school education and below (middle-school education: OR=1.91[95%CI: 0.678-1.193], $P=0.009$; primary education: OR=2.59 [95% CI 0.675-

1.199], $P < 0.001$; literate: OR=2.60 [95% CI 0.480- 0.928; illiterate: OR=2.89 [95% CI 0.220-0.572]), smoking (OR=1.36 [95% CI 1.109-1.677], $P=0.003$), North (OR=1.51[95% CI 1.02-2.078], $P=0.01$) or Northwest China residence (OR=1.70 [95% CI 1.170-2.472], $P=0.005$) were associated with prevalent asthma.

Conclusions: Asthma is prevalent but underappreciated among middle-aged and elderly people in China. A number of risk factors were identified. These results can help to formulate correct prevention and treatment measures for asthma.

Key words: Asthma, Prevalence, Trends, Epidemiology, Risk factors, China

1. Background

Asthma is one of the most prevalent chronic respiratory disorder, which is a major cause of disability, health resource utilization and socioeconomic burden worldwide¹⁻³. The World Health Survey (WHS) reported the global prevalence rates of doctor diagnosed asthma among individuals aged 18 to 45 years were 4.3% in 2002-2003⁴. Global Initiative for Asthma (GINA) Dissemination Committee Report estimated that asthma affects 300 million people worldwide in 2004⁵. The population with asthma worldwide increased to 358 million identified by Global Burden of Disease (GBD) Study in 2015 and the number is predicted to rise to 400 million by 2025⁵. Obviously, with the rapid development of global industrialization and urbanization, changes in the ecological environment, the prevalence of asthma were showing an upward trend.

In China, the China Asthma and Risk factors Epidemiologic(CARE) study reported a physician- diagnosed asthma prevalence of 1.2% for people aged $\geq$ 14 years from eight provinces/cities in 2012⁶. China Pulmonary Health (CHP) study reported this prevalence to be 4.2% in adults aged $\geq$ 20 years, on the basis of wheeze symptoms in the preceding 12 months or previous diagnosis by a physician from ten provinces/cities in 2015⁷. Differences in diagnosis of asthma and data collection might contribute to this inconsistency. All along, much attention has focused on childhood and adult asthma^{8,9}, but the population is ageing rapidly in China^{10,11} and many studies demonstrated the prevalence of asthma increased with age⁷. Therefore, it is desperately indispensable to describe the prevalence of asthma in middle-aged and elderly people. However, these

current studies are not up-to-date and cannot reflect the recent prevalence of asthma among middle-aged and elderly people in China.

Here, we used data from the CHARLS survey to describe the latest prevalence of asthma in Chinese individuals aged 45 years and older in 2018 and to assess the risk factors for asthma.

2.Methods

2.1. Study design and population

The current analysis base on the data from the fourth wave of CHARLS survey conducted by the National School of Development of Peking University in 2018. The details of the sampling design of this survey has been described previously¹². Briefly, CHARLS is a nationally representative survey targeting populations aged 45 and older from 450 villages/urban communities in 150 counties/districts in 28 provinces/cities in mainland China that provides information about demographics, geography, health status, and lifestyle variables. The study was carried out in 2018 with a response rate of 86%. The geographic and population distribution of 28 provinces/cities was presented in Fig. 1.

Overall, a total of 19816 participants were recruited for CHARLS in 2018, of whom 1312 were excluded due to incomplete information or age< 45 years. Eventually, 18045 participants were enrolled (see Fig. 2). Meanwhile, the Medical Ethics Committee approved the CHARLS study, and all interviewees were required to sign an informed consent form. Ethics approval for the data collection in CHARLS was obtained from

the Biomedical Ethics Review Committee of Peking University (IRB00001052–11015).

Ethics approval for the use of CHARLS data was obtained from the University of

Newcastle Human Research Ethics Committee (H-2015-0290).

2.2 Data collection

At each county or district unit, trained staff collected data according to a standard protocol in respondents' homes and local health stations or the local office of the China Center for Disease Prevention and Control (CDC). For each participant, an interview was conducted to collect information on sociodemographic characteristics (race, age, sex and education), geographic residence, lifestyle features (smoking, type of cooking fuels).

According to self-reported physician diagnosis of asthma, subjects were classified into two groups: Asthma and Non-Asthma. The participants' race was classified as Han and Minorities (Zhuang, Man, Hui, Miao, Weiwuer, Tujia, Yi, Mongol, Zangand or other). The participants were divided into four groups according to their age, namely 45-49 years old group, 50-59 years, 60-69 years, ≥ 70 years. The Educational attainments were classified as illiterate (no formal education), literate (did not finish primary school but capable of reading or writing), primary education (graduated from elementary school), and middle-school education (graduated from middle school) and high-school education above (graduated from high school, vocational school, college or post-graduate school). The participants' residence was classified as urban, urban-rural area or rural and categorized into six geographic regions, namely East China,

North China, Northeast China, Northwest China, South Central China and Southwest China¹³. According to the participants' smoking status, they were classified as never-smokers and smokers (smokers were defined as smoking more than 100 cigarettes in your life). The types of cooking fuels were classified as clean (natural gas, marsh gas, liquefied petroleum gas or electricity), unclean (coal, crop residue or wood burning).

2.3. Quality control

Fieldwork was conducted by independent enumerators who collected data using face-to-face computer assisted personal interview. Data were verified by CHARLS headquarters. Furthermore, the first two interviews were recorded to verify that participants performed the correct procedures. If the recording could not be completed owing to technical or other problems, CHARLS headquarters would call back for a phone check. Above technicians were trained to avoid information bias. Additionally, multistage stratified cluster sampling was used to resolve selection bias. Confounding factors was addressed with multivariable-adjusted logistic regression analysis.

2.4. Statistical analysis

In this study, the estimation of prevalence, risk factors of asthma were weighted by considering the study design and individual weight with individual and household non-response adjustment¹⁴. Metrical data with normal distribution were presented as mean $\pm$ standard deviation. Categorical data were presented as absolute counts and percentages. We assessed the differences of the proportions by Chi-square test. The associations between asthma and different characteristic variables were firstly explored

by univariate logistic regressions. Then we identified the potential risk factors by multivariable logistic regressions. Data clean and analysis were performed using Stata statistical software (version 15.0; Stata Corporation, College Station, TX, USA). *P*-value< 0.05 was regarded as statistically significant.

3. Results

3.1. Demographic

The study included 18504 subjects (8759 men and 9745 women) who aged 45 years and older and completed the survey. Of the total subjects, 17072 (92.26%) were Han Chinese and 1432 (7.74%) were other origins. Furthermore, 7761(41.94%) subjects were smokers. The distribution of our study population by general characteristics is summarized in Table 1.

3.2. Prevalence of asthma in 2018

Of the 18504 subjects, 399 were diagnosed with asthma. The total prevalence of asthma in Chinese people aged 45 years and older was estimated 2.16% (95% CI 1.96-2.38).

3.3. The prevalence of asthma with different characteristics

Among people aged 45 and over in China, the prevalence of asthma with Han and other ethnic groups was 2.06% (95% CI 1.86-2.29) and 3.28% (95% CI 2.47-4.34), respectively (*P*=0.002). The prevalence of asthma significantly increased with age, from 0.77% (95% CI 0.37-1.60) in individuals aged 45 to 59 years to 3.29% (95% CI 2.84-3.82, *P*<0.001) in those aged 70 years and older. The prevalence of asthma

significantly decreased with increasing education attainment, from 2.88% (95% CI 2.41-3.45) in adults who were illiterate to 0.91% (95% CI 0.61-1.38 $P<0.001$) in those who educated from high-school or above. We found that it significantly varied between different geographic regions in China, ranging from 1.56% (95% CI 1.01- 2.41) in eastern China to 3.14 (95% CI 2.32-4.24) in Northwest China ($P=0.005$). In never-smokers, the prevalence of asthma was 1.90% (95% CI 1.66-2.17), compared with 2.51% (95% CI 2.19-2.89) in smokers ($P=0.005$). The prevalence of asthma was 1.95% (95% CI 1.73-2.20) for those who use clean cooking fuels and 2.64% (95% CI 2.25-3.10, $P=0.03$) for those who use unclean cooking fuels. However, asthma prevalence did not differ between men (2.29% [95% CI 1.86-2.29]) and women (2.03% [95% CI 1.77-2.33], $P=0.219$) or between urban (1.86% [95% CI 1.48-2.35]), urban-rural (1.85% [95% CI 1.28-2.67]) and rural (2.27% [95% CI 2.03-2.54], $P=0.217$) area. The prevalence of asthma stratified according to different characteristics was presented in Table 2.

3.4 Socio-demographic, geographic and lifestyle factors associated with asthma

These statistically significant variables in the univariate model including race, age, education, geographic region, smoking status, cooking fuels were analyzed in the multivariable analysis. Multivariable logistic regressions analysis was performed for control for the effect of potentially confounding variables. Finally, it showed that the risk factors for asthma include the minorities, elderly people, smokers and North or Northwest China residence, while people with middle-school education and above are the protective factor for asthma. Minorities demonstrated to be a risk factor for asthma

compared with Han (OR=1.54 [95% CI 1.114-2.122], $P=0.009$). Those who aged 60 years or older had a higher risk to suffer from asthma than those who aged 45 years to 49 years (60-69 years group: OR=2.65 [95% CI 1.230-5.702], $P=0.013$; ≥ 70 years group: OR= 3.38 [95% CI 1.741-8.036], $P=0.001$). The prevalence of asthma was higher among smokers than non-smokers (OR=1.36 [95% CI 1.109-1.677], $P=0.003$). People living in North or Northwest China had a higher risk than those who living in East China (North China: OR=1.51[95% CI 1.02-2.078], $P=0.01$; Northwest China: OR=1.70 [95% CI 1.170-2.472], $P=0.005$). Additionally, subjects with middle-school education and below had a higher risk than those who were graduated from high-school or above (middle-school education: OR=1.91[95%CI: 0.678-1.193], $P=0.009$; primary education: OR=2.59 [95% CI 0.675-1.199], $P<0.001$; literate: OR=2.60 [95% CI 0.480-0.928; illiterate: OR=2.89 [95% CI 0.220-0.572]). There were no definite differences in asthma rates according to fuels type of cooking. The multivariable results were presented in Table 3.

Discussion

Our large comprehensive asthma survey in a nationally representative sample of Chinese individuals aged ≥ 45 years indicated that the total estimated prevalence of asthma in China in 2018 was 2.16%. The prevalence of asthma was higher among minorities than Han (3.28% vs 2.06%). In addition, we observed that the prevalence of asthma was the highest in people aged ≥ 70 years (3.29%), illiterate (2.88%) and

Northwest China (3.14%). Smokers were linked to a higher risk of asthma than non-smokers (2.51% vs 0.19%).

A cross-sectional survey based on CHRLS in 2011 published that the prevalence of asthma among individuals aged ≥ 45 years in China was 1.33%¹⁵. However, some of these asthma patients were classified as Asthma-Chronic obstructive pulmonary disease overlap (ACO) groups, which led to a lower prevalence of asthma than the value of 2.16% reported by our study. The CARE study was performed in 2010-2012, including 164215 Chinese people aged >14 years from eight provinces/cities (Shanghai, Guangdong, Beijing, Jiangsu, Sichuan, Henan, Liaoning and Shanxi), which estimated that the prevalence of asthma among individuals aged >14 years in mainland China was 1.24%. Our study was a large-scale investigation geographically covered 28 out of 31 provinces in mainland China. It reported that the rate of asthma among people aged ≥ 45 years was 2.16%, which was similar to the value of 2.18% among people aged > 50 years reported by CARE study⁶. Furthermore, the CHP study reported this prevalence to be 4.2% based on wheeze symptoms or physician diagnosis from ten provinces/cities in 2015, which was higher than our study. Although the demographic characteristics of the subjects in these studies were not exactly matched, the higher prevalence reported by CHP study may be partly explained by diagnostic criterion including wheeze symptoms, which could potentially have led to the misclassification of Chronic Obstructive Pulmonary Disease(COPD) as asthma due to both diseases present with wheezing⁷. Additionally, in the middle-aged and elderly population, the older the age,

the higher the prevalence of asthma^{6,7,15}. Given that China has the largest aging population in the world, and is one of the highest aging rates in the world today¹⁰, it is essential to pay more attention to the asthma among people aged ≥ 45 years.

Multivariate analysis demonstrated that the primary risk factors of asthma among people aged ≥ 45 years were minorities, elderly people (≥ 60 years), middle-school education and below, smokers, North and Northwest China residence. Data generated from countries with multi-ethnic populations presented significant differences in the relative rates of asthma by ethnicity. In the United States, for example, the prevalence of asthma among Hispanics, Caucasians, African Americans, and Puerto Ricans was 6.6%, 7.8%, 10.3%, and 13.7%, respectively¹⁶⁻¹⁹. UK data suggested the prevalence of asthma was higher in those of African descent and lower in South Asians as compared with Caucasians^{20,21}. In contrast, the Han Chinese were significantly associated with decreased prevalence of asthma, independent of other risk factors. Genetics clearly plays a role in the link between asthma and ethnicity. But, thus far, no specific gene has been exactly explained an ethnic susceptibility to asthma. Theo J. Moraes et al. proposed that asthma is a heterogeneous disease caused by complex interactions between genetic and environmental factors²². Further research into the race-related causes of asthma is needed. Ethnic variation in asthma prevalence helps to formulate correct prevention and treatment measures for asthma.

Recent studies suggested a relationship between asthma and age. Those studies indicated that the prevalence of asthma increased with age^{6,23-25}, consistent with our

study. For people aged 45-49 years, the odds of asthma among people aged 60-69 years were approximately increased by 2.6 folds and those over 70 were increased by 3.7 folds. In Korea, a survey of adult asthma incidence based on National Health Insurance Service–National Sample Cohort (NHIS-NSC) observed that incidence rates increased with age, subjects aged 70 or over showed the highest asthma prevalence ²⁶. Furthermore, some studies have reported that the aggravation rate and mortality rate of asthma patients over 55 years old were significantly increased ²⁵, suggesting the necessary to pay more attention to the aged and strengthen the care of asthmatics who over 60 years old.

Recent studies observed a relationship between asthma and smoking. In a case-control study, the population consisted of adults aged 21–63 years, reported that the risk of asthma was higher among smokers with a odds ratio of 1.33 than never-smokers²⁷, which was similar to the odds ratio of 1.36 in our study. On the other hand, Cigarette smoking and asthma interact to trigger certain adverse effects on clinical, therapeutic and prognostic outcomes²⁸. Quitting smoking can improve lung function and symptoms, but the low rates of smoking cessation emphasise the need for improved strategies for managing these patients.

Besides above, the prevalence of asthma significantly differs according to different regions in mainland China. The prevalence of asthma in East China, North China, Northeast China, South Central China, Southwest China was 1.86%, 2.67%, 1.56%, 3.14%, 1.88% and 2.48%, respectively. The prevalence of asthma in Northern and

Northwestern China was 1.5 to 1.7 times higher than in Eastern China and the two regions should be drawn more attention. Another notable risk factor was middle-school education and below, which was significantly correlated with the risk of asthma in accordance with previous studies ^{7,15}. With the lower education attainment, the prevalence of asthma increased. Compared with those who graduated from high-school and above, the risk of asthma was 1.91 times for those who graduated from middle-school, 2.59 times for those who graduated from elementary school, 2.60 times for those who were literate and 2.89 times for those who were illiterate. It can be interpreted as the lower the level of education, the less the health consciousness and the worse the living environment.

Conflicting results have been reported regarding the association of gender with asthma prevalence^{7,29}. A survey from three cross-sectional samples in Sweden showed that the increase in asthma was most pronounced among women from 1996 to 2016²⁹. But, the CHP study showed the asthma prevalence did not differ between male and female, consistent with our study. The reason may be caused by the higher smoking of male in China. We also observed that those who lived in rural not did provide protection from asthma in accordance with other studies ^{30,31}. In fact, the difference in asthma caused by urban and rural was still connected with the environment. There was sufficient evidence to suggest that air pollutants, such as ozone and particulate matter, trigger exacerbations of asthma, decrease lung function and increase rates of asthma³². The

result may be masked by the stronger effort of smoking⁷ or indicate that a rapid decrease in air pollution is already occurring in China.

The univariate results in this survey demonstrated that the prevalence of asthma was higher in individuals with unclean cooking fuels than in those with clean cooking fuel. But multivariate regression analysis suggested that the type of cooking was not really relevant to asthma, consistent with the CHP study⁶. Actually, it also observed that the asthma risk of biomass use might be masked by the stronger effect of smoking⁷, which needs further research to confirm.

This study has the following advantages. First, CHARLS is a nationally representative survey targeting populations aged 45 and older from 450 villages or communities in 150 counties or districts in 28 provinces of mainland China, which enabled us to estimate the prevalence of asthma. Second, this study adopted a multistage cluster sampling in six areas of mainland China (East China, North China, Northeast China, Northwest China, South Central China and Southwest China), which avoided selection bias. Third, strict quality control assured a high quality of data collection and reliability of the findings. This study also has several limitations. On the one hand, we did not include individuals younger than 45 years. Thus we cannot provide information on those who aged < 45 years. On the other hand, asthma was identified by self-reported physician diagnoses rather than spirometry measurements, but it also reflexed the prevalence of asthma in mainland China.

Conclusions

Asthma is prevalent but underappreciated among middle-aged and elderly people in China. The risk factors for asthma include the Minorities, elderly people, illiterate and North or Northwest China residence. These results can help to formulate correct prevention and treatment measures for asthma.

Declarations

Abbreviations

CHARLS: China Health and Retirement Longitudinal Study; WHS: World Health Survey; GINA: Global Initiative for Asthma; GBD: Global Burden of Disease; CARE: China Asthma and Risk factors Epidemiologic; CHP: China Pulmonary Health; CDC: China Center for Disease Prevention and Control; NHIS-NSC: National Health Insurance Service–National Sample Cohort.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was conducted in accordance with the declaration of Helsinki.

The study was approved by the Biomedical Ethics Review Committee of Peking University (IRB00001052–11015). Ethics approval for the use of CHARLS data was obtained from the University of Newcastle Human Research Ethics Committee (H-2015-0290). And all the participants gave their written informed consent before any study procedures began.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Authors' contributions

Study design: JW, JL; Data analysis: JW, QZ, CL; Paper writing: JW; Paper revise: JL.

All authors read and approved the final manuscript.

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479 **Table 1** General characteristics of the participants among aged 45 and older

Characteristic	Non- Asthma	Asthma	Overall
Participants	18105 (97.8%)	399 (2.16%)	18504 (100%)
Race			
Han	16720 (92.4%)	352 (88.2%)	17072 (92.3%)
Minorities	1385 (7.6%)	47 (11.8%)	1432 (7.7%)
Sex			
Male	8558 (47.3%)	201 (50.4%)	8759 (47.3%)
Female	9547 (52.7%)	198 (49.6%)	9745 (52.7%)
Age group			
45-49 years	908 (5.0%)	7 (1.8%)	915 (4.9%)
50-59 years	6384 (35.3%)	92 (23.0%)	6476 (35.0%)
60-69 years	5880 (32.5%)	132 (33.1%)	6012 (32.5%)
≥70 years	4933 (27.2%)	168 (42.1%)	5101 (27.6%)
Education			
High-school or above	2390 (13.2%)	22 (5.5%)	2412 (13.0%)
Middle-school	4042 (22.3%)	67 (16.8%)	4109 (22.2%)
Primary education	3985 (22.0%)	98 (2.5%)	4083 (22.1%)
Literate	3748 (20.7%)	95 (23.8%)	3843 (20.8%)
Illiterate	3940 (21.8%)	117 (29.3%)	4057 (21.9%)
Residence setting			

Urban	3684 (20.3%)	70 (17.6%)	3754 (20.3%)
Urban-rural area	1485 (8.2%)	28 (7.0%)	1513 (8.2%)
Rural	12936 (71.5%)	301 (75.4%)	13237 (71.5%)
Geographic region			
East	5584 (30.8%)	106 (26.6%)	5690 (30.8%)
North	2517 (13.9%)	69 (17.3%)	2586 (14.0%)
Northeast	1260 (7.0%)	20 (5.0%)	1280 (6.9%)
Northwest	1265 (7.0%)	41 (10.3%)	1306 (7.0%)
South Central	3145 (23.9%)	83 (20.8%)	3225 (23.9%)
Southwest	3145 (17.4%)	80 (20.0%)	3225 (17.4%)
Smoking status			
Never-smokers	10539 (58.2%)	204 (51.1%)	10743 (58.1%)
Smokers	7566 (41.8%)	195 (48.9%)	7761 (41.9%)
Type of cooking			
Clean	12725 (70.3%)	253 (63.4%)	12978 (70.1%)
Unclean	5380 (29.7%)	146 (36.6%)	5525 (29.9%)

Smokers were defined as having smoked more than 100 cigarettes in their lifetime.

485 **Table 2** The prevalence of asthma by different characteristics among people aged 45
 486 and older

Characteristic	Prevalence (%)	95%CI	<i>P</i>
Race			0.002
Han	2.06%	1.86-2.29	
Minorities	3.28%	2.47-4.34	
Sex			0.219
Male	2.29%	2.00-2.63	
Female	2.03%	1.77-2.33	
Age group			<0.001
45-49 years	0.77%	0.37-1.60	
50-59 years	1.42%	1.16-1.74	
60-69 years	2.20%	1.85-2.60	
≥70 years	3.29%	2.84-3.82	
Education			<0.001
High-school or above	0.91%	0.60-1.38	
Middle-school	1.63%	1.29-2.07	
Primary education	2.40%	1.97-2.92	
Literate	2.47%	2.03-3.01	
Illiterate	2.88%	2.41-3.45	
Residence setting			0.217

Urban	1.86%	1.48-2.35	
Urban-rural area	1.85%	1.28-2.67	
Rural	2.27%	2.03-2.54	
Geographic region			0.005
East	1.86%	1.51-2.28	
North	2.67%	2.11-3.36	
Northeast	1.56%	1.01-2.41	
Northwest	3.14%	2.32-4.24	
South Central	1.88%	1.55-2.28	
Southwest	2.48%	2.00-3.08	
Smoking status			0.005
Never-smokers	1.90%	1.66- 2.17	
Smokers	2.51%	2.19- 2.89	
Type of cooking			0.003
Clean	1.95%	1.73-2.20	
Unclean	2.64%	2.25-3.10	

CI: confidence interval. The *P* value was calculated using Chi-square

492 **Table 3** Relationship of risk factors and the prevalence of asthma from the
 493 multivariable regression analysis

Risk factor	OR (95% CI)	<i>P</i>
Race		
Han (reference)	1.00	..
Minorities	1.54 (1.114-2.122)	0.009
Age		
45-49 years (reference)	1.00	..
50-59 years	1.80 (0.830-3.893)	0.137
60-69 years	2.65 (1.230-5.702)	0.013
≥70 years	3.74 (1.741-8.036)	0.001
Education		
High-school or above (reference)	1.00	..
Middle-school	1.91 (0.678-1.193)	0.009
Primary education	2.59 (0.675-1.199)	< 0.001
Literate	2.60 (0.480-0.928)	< 0.001
Illiterate	2.89(0.220-0.572)	< 0.001
Geographic region		
East (reference)	1.00	..
North	1.51 (1.102-2.078)	0.010

Northeast	0.86 (0.524-1.399)	0.536
Northwest	1.70 (1.170-2.472)	0.005
South Central	1.04 (0.772-1.388)	0.818
Southwest China	1.16 (0.857-1.571)	0.335

Smoking status

Never-smokers (reference)	1.00	..
Smokers	1.36 (1.109-1.677)	0.003

Type of cooking

Clean (reference)	1.00	..
Unclean	1.07 (0.859-1.323)	0.563

494 OR: odds ratio; CI: confidence interval.

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Figure legends

Fig. 1 Geographic and population distribution of 28 provinces/cities in the CHARLS in 2018. Each province/city on the map is gradually darkens in color as the number of participants increases.

Fig. 2. Flow chart for subjects enrolled in this study. Missing data refers to incompleteness of demographic/geographic/lifestyle information

Fig. 1

Fig. 2

Figures

Figure 1

Geographic and population distribution of 28 provinces/cities in the CHARLS in 2018. Each province/city on the map is gradually darkens in color as the number of participants increases. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 2

Flow chart for subjects enrolled in this study. Missing data refers to incompleteness of demographic/geographic/lifestyle information