# Association between tobacco smoking and heart disease in older adults: a cross-sectional study based on the Chinese Longitudinal Healthy Longevity Survey

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**Background:** The association between the risk of heart disease and tobacco smoking has been studied in previous work, but there are arguments among various population. We aimed to investigate the association between heart disease incidence and smoking status among older adults.

**Methods:** A cross-sectional analysis was conducted with 10,891 older adults in the 2 most recent waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), 2011–2014 and 2014–2018. The data included individual weighting variables to ensure they were nationally representative. The parameters consisted of age, sex, body mass index (BMI), smoking status, and disease history was collected. Smoking measures included current/former/never status, pack-years and the time to first cigarette. Heart disease included coronary artery disease, arrhythmias, heart failure, valve diseases and other heart conditions. Respondents with missed values were excluded. Multivariable logistic regression analyses were performed.

**Results:** Among the 10,006 respondents included in the analyses, 4,501 (44.9%) were men. The median age was 88 years old [interquartile range (IQR), 78–96]. A total of 6,713 respondents (67.1%) were nonsmokers, 1,695 respondents (16.9%) were former smokers, and 1,598 respondents (16.0%) were current smokers. The incidence of heart disease was significantly higher in smokers compared with nonsmokers (14.5% *vs.* 12.8%, P=0.018). Female smokers and those over 80 years old had higher morbidity than male smokers. After adjusting for sex, age, BMI, hypertension, diabetes, area of residency, alcohol status, and exercise status, smokers still had an increased risk of heart disease [odds ratio (OR) 1.29, 95% confidential interval (CI): 1.10–1.50, P=0.001]. The incidence of heart disease also increased with higher intensity of smoking for each additional pack-year (OR 1.01, 95% CI: 1.00–1.02, P=0.011).

**Conclusions:** For elderly adults, current or former smoking was largely associated with heart disease incidence, especially in females and those over 80 years old. These variables could be considered for inclusion in future heart disease risk prediction models.

**Keywords:** Tobacco smoking; cardiovascular diseases; older adults; health survey; pack-year

Submitted Nov 16, 2022. Accepted for publication Jan 06, 2023. Published online Jan 13, 2023.
doi: 10.21037/atm-22-6344
**View this article at:** https://dx.doi.org/10.21037/atm-22-6344

## Introduction

Tobacco smoking is the world's primary cause of preventable death. In 2019, smoking was responsible for nearly 7.69 million deaths and 200 million disability-adjusted life-years globally (1). Smoking prevalence in China has been consistently high, with current smokers comprising 25.2% of the population (2,3). A leading cause of death attributable to smoking is heart disease. Much of the evidence for the link between smoking and heart disease has appeared since 1986 (4). There are dozens of epidemiological studies on the relationship between exposure to tobacco smoke and the risk of heart disease (5,6). Overall, active or passive smoking is among the risk factors for heart disease.

The incidence of heart disease varies considerably by age. The US National Center for Health Statistics reports that men in various age groups suffer from heart disease at rates of 9.5% (45–54 years), 16.7% (55–64 years), 29.8% (65–74 years), and 42.1% (75 years or older) (7). As older adults experience higher rates of chronic disease, they are especially vulnerable to heart disease-related morbidity and mortality (8). As a result, the statistical power to investigate the effects of smoking on heart disease in older adults is limited. Whether smoking cessation is of high priority in older adults remains uncertain. Some studies have suggested that smoking is only a weak risk factor for the elderly, and that the relative risk of heart disease associated with smoking attenuates in old age (9-12). The incidence of heart disease may be high in old age group, and hence the burden of disease is much greater than in the young age groups.

### Highlight box

**Key findings**

- Current or former smoking increases the risk of heart disease in elderly adults.

**What is known and what is new?**

- The association between the incidence of heart disease and smoking status has been demonstrated, but whether smoking cessation is of high priority in older adults remains uncertain.
- Based on a large-sample population-based survey, we concluded that heart disease was attributable to current or former cigarette smoking for older adults, especially for females and those over 80 years old.

**What is the implication, and what should change now?**

- Smoking cessation is of high priority in older adults to reduce risk of cardiovascular disease.

With an increasingly elderly population, it is important to identify patterns in risk factor strength by age.

Studies based on population-based survey data with large sample sizes are useful for improving the understanding of how smoking and heart disease are related. Therefore, we analyzed data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which collected information on sociodemographic characteristics and self-reported health from over 10,000 older adults. The present study aimed to investigate associations between the incidence of heart disease and smoking status, adjusting for age, sex, and other risk factors. We present the following article in accordance with the STROBE reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-22-6344/rc).

## Methods

### *Sample and data*

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Biomedical Research Ethics Committee of West China Hospital, Sichuan University. The data used in this study were derived from the 2 most recent waves of CLHLS, a nationwide, ongoing, and prospective cohort study of community-dwelling Chinese older people (13). A total of 23 of the 34 Chinese provinces were surveyed, covering roughly half the counties and city districts. The data included individual weighting variables to ensure they were nationally representative. Datasets from the 2011–2014 and 2014–2018 waves were chosen, which included 3,699 and 7,192 survey respondents, respectively. The effect of tobacco smoking on human health is a long-term process, and all subjects included in this study were apparently older adults with a limited life expectancy. Therefore, we conducted a cross-sectional study instead of a longitudinal study to increase the number of samples with complete data. We excluded respondents with missing information on smoking or potential confounders from further analysis. After processing the missing values, the final sample for analysis consisted of 10,006 respondents (*Figure 1*).

### *Variables*

A questionnaire was used to collect data on demographic factors, physiological health conditions, and chronic disease prevalence, including age, gender, area of residence, smoke

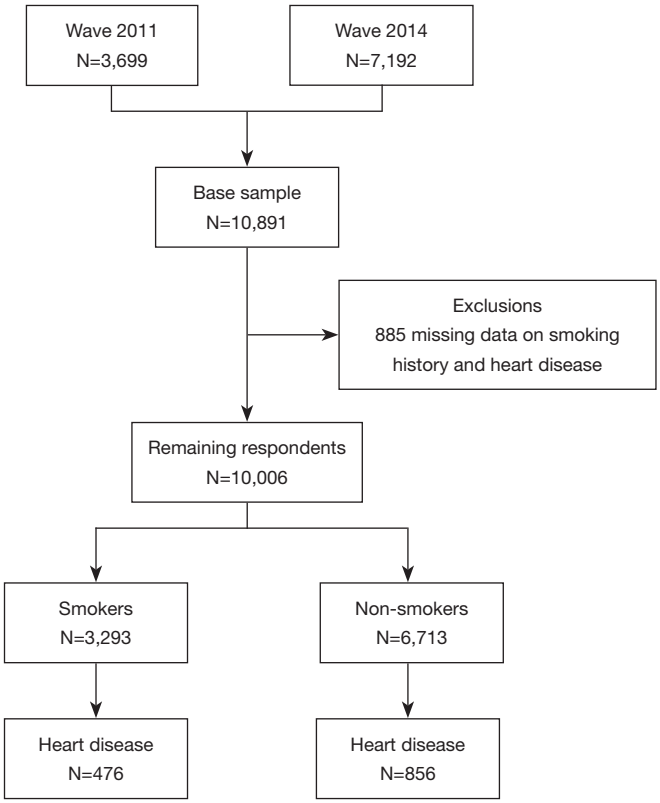


**Figure 1** Sample flow diagram.

exposure, and chronic diseases or conditions. Regarding the diagnosis of heart disease, participants were asked on questionnaire whether they had been diagnosed with heart disease by doctors. Body mass index (BMI) was calculated as weight divided by height squared. Present and former smoking status were classified into "current", "former", and "never". Smoking was quantified in pack-years, which refers to smoking 1 pack of cigarettes per day each year. The number of pack-years is calculated as follows: (number of cigarettes smoked per day) × (years as a smoker)/20 (where 1 pack of cigarette contains 20 cigarettes). The time to first cigarette (TTFC), an item from the Fagerstrom Test for Nicotine Dependence (FTND) (14), is an objective measure of nicotine dependence and is associated with a range of behavior traits of nicotine dependence. A low dependent phenotype is characterized by smoking >30 minutes after waking and smoking ≤20 cigarettes per day, while a high dependent phenotype is characterized by smoking ≤30 minutes after waking. History of heart disease, diabetes, and hypertension were classified into "presence" and "absence".

### *Statistical analysis*

Normally distributed continuous measurements are expressed as mean ± standard deviation (SD), while nonnormally distributed continuous measurements are expressed as medians [interquartile range (IQR)]. Categorical variables are presented as frequencies (percentage). The incidence of heart disease between smokers and nonsmokers among older adults was compared using the $\chi^2$ test. Two sets of covariates were used in multivariable logistic regression models to explore the relationship between heart disease and smoking status parameters (2 models, respectively). Based on the basic covariate set adjusted for age and sex, Model 1 was applied; Model 2 was applied to the extended covariate set which included age, sex, BMI, diabetes history, and hypertension history; and Model 3 was applied based on Model 2 adjusted for area of residency, alcohol status, and exercise status. Adjusted odds ratio (aOR) and 95% confidence intervals (CIs) were calculated to assess the strength of the smoking-heart disease relationship. No more than 0.20% of the baseline variables had missing values, and due to this very

low rate, the cases with missing values were deleted in final statistical analyses without being imputed. All analyses were performed using SPSS version 23.0 (IBM, Chicago, IL, USA) and GraphPad Prism version 9.0 (GraphPad Software, La Jolla, CA, USA). For statistical analyses using the two-sided test, P<0.05 was considered a significant difference.

## Results

The characteristics of participants from the 2 CLHLS cohorts are displayed in *Table 1*. There were 3,293 (32.9%) current or former smokers and 6,713 (67.1%) nonsmokers. The median age was 84 (IQR, 76–92) years among smokers and 89 (IQR, 80–97) years among nonsmokers. Most

**Table 1** Participant characteristics from datasets of the selected CLHLS waves by tobacco user group

| Characteristics | Smoker (n=3,293) | Nonsmoker (n=6,713) | P value |
|---|---|---|---|
| Age (years), median (IQR) | 84 (76, 92) | 89 (80, 97) | <0.001 |
| Male, n (%) | 2,681 (81.4) | 1,820 (27.1) | <0.001 |
| Region of residence, n (%) | | | <0.001 |
| Urban | 579 (17.6) | 1,061 (15.8) | |
| Town | 1,035 (31.4) | 1,923 (28.7) | |
| Rural | 1,679 (51.0) | 3,729 (55.5) | |
| Self-reported health, n (%) | | | <0.001 |
| Very good | 321 (9.7) | 475 (7.1) | |
| Good | 1,057 (32.1) | 2,148 (32.0) | |
| So so | 1,201 (36.5) | 2,345 (34.9) | |
| Bad | 464 (14.1) | 903 (13.4) | |
| Very bad | 48 (1.5) | 99 (1.5) | |
| Not able to answer or missing | 202 (6.1) | 743 (11.1) | |
| Frequency of eating vegetables, n (%) | | | 0.001 |
| Almost everyday | 1,847 (56.1) | 3,515 (52.4) | |
| Except winter | 1,033 (31.4) | 2,194 (32.7) | |
| Occasionally | 279 (8.5) | 645 (9.6) | |
| Rarely or never | 123 (3.7) | 320 (4.7) | |
| Not able to answer or missing | 11 (0.3) | 39 (0.6) | |
| Drinking alcohol at present, n (%) | | | <0.001 |
| Yes | 893 (27.1) | 594 (8.9) | |
| No | 2,378 (72.2) | 6,036 (89.9) | |
| Not able to answer or missing | 22 (0.7) | 82 (1.2) | |
| Exercise at present, n (%) | | | <0.001 |
| Yes | 1,028 (31.2) | 1,564 (23.3) | |
| No | 2,208 (67.1) | 4,981 (74.2) | |
| Not able to answer or missing | 57 (1.7) | 168 (2.5) | |

**Table 1** (*continued*)

**Table 1** (*continued*)

| Characteristics | Smoker (n=3,293) | Nonsmoker (n=6,713) | P value |
|---|---|---|---|
| Education level, n (%) | | | <0.001 |
| None or primary school education | 2,717 (82.4) | 6,103 (90.9) | |
| Middle school education | 493 (14.9) | 472 (7.0) | |
| University education or higher | 72 (2.2) | 68 (1.0) | |
| Not able to answer or missing | 16 (0.5) | 70 (1.0) | |
| Economic status, n (%) | | | 0.002 |
| Very rich | 44 (1.3) | 96 (1.4) | |
| Rich | 523 (15.9) | 909 (13.6) | |
| Fair | 2,276 (69.1) | 4,723 (70.6) | |
| Poor | 346 (10.5) | 700 (10.5) | |
| Very poor | 72 (2.2) | 143 (2.1) | |
| Not able to answer or missing | 32 (1.0) | 122 (1.8) | |
| Current marital status, n (%) | | | <0.001 |
| Unmarried | 57 (1.7) | 36 (0.5) | |
| Married | 1,631 (49.5) | 1,890 (28.2) | |
| Widowed or divorced | 1,579 (48.0) | 4,706 (70.1) | |
| Not able to answer or missing | 26 (0.8) | 81 (1.2) | |
| BMI (kg/m$^2$), median (IQR) | 21.3 (18.9, 23.6) | 20.8 (18.5, 23.7) | 0.003 |
| Systolic pressure (mmHg), median (IQR) | 136 (122, 150) | 138 (124, 151) | <0.001 |
| Diastolic pressure (mmHg), median (IQR) | 80 (70. 88) | 80 (70, 90) | 0.233 |
| Current smoker, n (%) | 1,598 (48.5) | – | |
| Former smoker, n (%) | 1,695 (51.5) | – | |
| Cigarettes/day, median (IQR) | 10 (5, 20) | – | |
| Cumulative pack-year, median (IQR) | 33.5 (18.0, 55.0) | – | |
| The time to first cigarette (min), n (%) | | | |
| <5 | 446 (22.5) | – | |
| 5–30 | 522 (26.4) | – | |
| 31–60 | 257 (13.5) | – | |
| >60 | 714 (37.6) | – | |
| Secondhand smoke exposure, n (%) | 1,782 (54.1) | 1,961 (29.2) | <0.001 |
| Heart disease, n (%) | 476 (14.5) | 856 (12.8) | 0.018 |
| Hypertension, n (%) | 1,010 (30.7) | 2,093 (31.2) | 0.606 |
| Diabetes, n (%) | 178 (5.4) | 321 (4.8) | 0.178 |

CLHLS, Chinese Longitudinal Healthy Longevity Survey; IQR, interquartile range; BMI, body mass index.

**Table 2** Logistic regression coefficients between smoking and heart disease

| Variables | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | aOR (95% CI) | P value | aOR (95% CI) | P value | aOR (95% CI) | P value |
| Smoking (yes/no) | 1.27 (1.10–1.46) | 0.001 | 1.29 (1.10–1.50) | 0.001 | 1.35 (1.11–1.66) | 0.003 |
| Smoking status (current/former) | 0.57 (0.47–0.70) | <0.001 | 0.59 (0.48–0.73) | <0.001 | 0.78 (0.61–0.99) | 0.042 |
| Smoking status (former/never) | 1.26 (1.09–1.46) | 0.002 | 1.27 (1.08–1.48) | 0.003 | 1.31 (1.07–1.60) | 0.010 |
| Frequency (pack-year) | 1.01(1.00–1.01) | 0.018 | 1.01 (1.00–1.02) | 0.011 | 1.02 (1.00–1.03) | 0.008 |
| The time to first cigarette (1/2/3/4) | 0.93 (0.83–1.05) | 0.228 | 0.91 (0.80–1.03) | 0.121 | 0.88 (0.80–1.06) | 0.254 |
| Nicotine dependence (high/low) | 0.87 (0.65–1.16) | 0.335 | 0.81 (0.59–1.10) | 0.168 | 0.78 (0.41–1.47) | 0.436 |
| Secondhand smoke exposure (yes/no) | 1.22 (1.09–1.38) | 0.001 | 1.14 (1.00–1.29) | 0.043 | 0.99 (0.84–1.17) | 0.933 |

Model 1: adjusted for age and sex. Model 2: Model 1 adjusted for BMI, history of diabetes and hypertension. Model 3: Model 2 adjusted for residency area, drinking status and exercise status. The time to first cigarette: 1: <5 minutes; 2: 6–30 minutes; 3: 31–60 minutes; 4: >60 minutes. aOR, adjusted odd ratio; CI, confidence intervals; BMI, body mass index.

smokers were male (2,681/3,293, 81.4%), while only 1,820 (27.1%) men were nonsmokers. The median BMI was also significantly higher among smokers (21.3 *vs.* 20.8, P=0.003), where 21.3% (702/3,293) had a BMI >24, compared to 22.0% (1,477/6,713) for nonsmokers (P=0.436). More than half of the smokers reported a history of secondhand smoke exposure during childhood and adolescence, which is far more than nonsmokers (54.1% *vs.* 29.2%, P<0.001).

The incidence of heart disease among smokers was 14.5%, and in nonsmokers, it was 12.8% (P=0.018). Subgroup analysis showed that the incidence of heart disease was higher among smokers for both males (13.8% *vs.* 11.2%, P=0.008) and females (17.2% *vs.* 13.4%, P=0.010). Female smokers had a higher risk of heart disease than male smokers (P=0.035). However, the correlation between smoking and heart disease was not significant in respondents under 80 years old (14.8% *vs.* 16.7%, P=0.154). There was no difference in the prevalence of heart disease among smokers at the 4 grades of TTFC (10.1%, 10.5%, 13.1%, and 12.2%, respectively, P=0.490). Smokers with high nicotine dependence had a similar incidence of heart disease to those with low nicotine dependence (10.3% *vs.* 13.1%, P=0.073).

After adjusting for potential confounders, multiple logistic regression analysis was conducted. *Table 2* shows the relationships between heart disease incidence and smoking, including direct and indirect smoke exposure. The incidence of heart disease was significantly associated with smoking in both models (Model 1: aOR 1.27, 95% CI: 1.10–1.46, P=0.001; Model 2: aOR 1.29, 95% CI: 1.10–1.50, P=0.001; Model 3: aOR 1.35, 95% CI: 1.11–1.66, P=0.003). Former smokers who had quit smoking were also at higher risk of heart disease (aOR 1.27, 95% CI: 1.08–1.48, P=0.003). The incidence of heart disease increased with higher intensity of smoking for each additional pack-year, and the trend reached statistical significance (aOR 1.01, 95% CI: 1.00–1.02, P=0.011). TTFC (aOR 0.91, 95% CI: 0.80–1.03, P=0.121) and nicotine dependence (aOR 0.81, 95% CI: 0.59–1.10, P=0.168) showed no effect on heart disease incidence. It was observed that the incidence of heart disease was higher with secondhand smoke exposure (aOR 1.14, 95% CI: 1.00–1.29, P=0.043).

## Discussion

In the present study, we examined relationships between smoking and heart disease for Chinese adults aged 65 years or older. One large-sample study was accessed for cross-sectional analysis. The incidence of heart disease was found to be significantly associated with smoke exposure, especially for females and those over 80 years old. In addition, the larger the amount of tobacco smoked, the higher the risk of heart disease.

Cigarette smoking is associated with increased risk of heart disease due to multiple factors, including exposure to hazardous components of tobacco smoke and interactions with various physiologic processes (15,16). Tobacco smoke contains oxidizing chemicals, nicotine, and carbon monoxide, as well as particulates and heavy metals (17). Oxidizing chemicals are responsible for lipid formation

and oxidative stress in arteries. Nicotine exposure affects hemodynamics, including blood pressure and heartbeat, resulting in higher cardiac output, while vasoconstricting effects of nicotine also reduce blood flow, thus decreasing oxygen supply (18). Arrhythmogenesis and fatal cardiac events are also associated with nicotine. Moreover, smoking increases endothelial dysfunction, hypercoagulability, inflammation, insulin resistance, and low-density lipoprotein (LDL) cholesterol levels. As a result, there is increased endovascular deposition and atherosclerosis within coronary vessels (19,20).

This study found a pattern of developing heart disease among men and women that was similar to previous results from the US Health and Retirement Study and the China Health and Retirement Longitudinal Study (21). In China, fewer women than men smoke, which could be related to health inequities and socioeconomic backgrounds. Smoking was associated with prevalence of heart disease, with increased risk for women. This was consistent with previous research reporting that women who smoke in China have higher mortality rates and worse prognosis after acute cardiovascular events (16,22-24). Based on the impact of smoking on heart disease among females, future health care strategies should address this behavior in women to better control heart disease.

Our results have important public health implications. First, smoking prevention should remain a high priority at any age. Heart disease caused by smoking also occurs in older adults who had quit smoking and those who were exposed to secondhand smoke, which was consistent with previous studies (25,26). The incidence of heart disease was high in female smokers, and hence the burden of disease is much larger than that in the male population. Second, our study was one of only a few studies to focus on the effect of smoking on cardiovascular disease among the elderly (27). We analyzed a large body of data with thorough assessments of relevant potential confounders. The large size of the study population increased the reliability of the findings.

Our study had several limitations. First, as the study sample came from 23 provinces, the unselected provinces were not represented in our study. Second, "heart disease" in the questionnaire was poorly defined. Intermittent palpitations and asymptomatic arrhythmias may have been ignored by respondents and may have caused an underestimation of prevalence. Third, the survey instrument relied on self-reported information, which may have led to underreporting and misreporting. Fourth, due to the cross-sectional nature and lack of survival data analysis, the evidence quality of the results concerning prevalence risk factors was low.

## Conclusions

In conclusion, we utilized pooled datasets of 2 waves of CLHLS and demonstrated that heart disease was attributable to current or former cigarette smoking for older adults, especially for females and those over 80 years old. High intensity of smoking was associated with increased risk of heart disease. The findings from older populations suggested that health promotion and reducing the burden of heart disease might be enhanced by early control and management of smoking.

## Acknowledgments

*Funding:* This study was supported by the Sichuan Science and Technology Program, China (Grant No. 2022YFS0186) and the National Natural Science Foundation of China (Grant No. 81600299).

## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-22-6344/rc

*Conflicts of Interest*: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-22-6344/coif). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Biomedical Research Ethics Committee of West China Hospital, Sichuan University. All data were collected from public databases.



 

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**Cite this article as:** Liu M, Zheng M, He S. Association between tobacco smoking and heart disease in older adults: a cross-sectional study based on the Chinese Longitudinal Healthy Longevity Survey. Ann Transl Med 2023;11(2):63. doi: 10.21037/atm-22-6344