Title: The prevalence and risk factors of chronic obstructive pulmonary disease (COPD) in a middle-aged and older Chinese population: Results from China Health and Retirement Longitudinal Study

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Contributors

Lei Zhu had the research idea, did the statistical analysis, wrote the paper and was responsible for this study. Le Zhang engaged in doing the statistical analysis. Lei Zhu and Fengwei Li were responsible for data interpretation and revision. Zhongwei Jia and Zuhong Lu were responsible for supervision or mentorship. All authors have seen and approved the final version of the paper for publication.

Declaration of interests

We declare no competing interests.

Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is the fourth leading cause of death worldwide. More than 90% of COPD deaths occur in low- and middle-income countries, such as China. However, the prevalence rate of COPD in China is unclear. This study was to estimate the national prevalence of COPD in China and to identify unique risk factors for it in order to improve detection rate. Furthermore, develop cost-effective strategies to control the COPD.

Methods: The China Health and Retirement Longitudinal Study(CHARLS) national survey conducted face-to-face household-interview by the use of a structured questionnaire in consideration of complex survey design and response rate. Survey logistic was used to identify the risk factors and confirmed in the longitudinal study.

Result: The overall prevalence rate of COPD is 10·11% (95% CI: 9·50% 10·76%). And the median of PEF between COPD group and non-COPD group were different significantly ($P< 0.001$, using Wilcoxon Rank Sum Test). The PEF of COPD and non-COPD were 200 and 300 respectively. In addition, gender, province variable, area variable, smoking, living standard, heart problems, liver disease and kidney disease were confirmed to be risk factors of COPD in the longitudinal analysis.

Conclusion: In conclusion, this study estimated that 10·11% of Chinese adults ≥ 45 years old reported having COPD overall. The prevalence and incidence rates of COPD increased with increasing age and males had higher prevalence and incidence rates. In addition, the western part of China had higher prevalence and incidence rate. Except for smoking, heart disease, liver diseases and kidney disease may be novel risk factor for COPD.

The prevalence and risk factors of chronic obstructive pulmonary disease (COPD) in a middle-aged and older Chinese population: Results from China Health and Retirement Longitudinal Study

Introductions

Chronic obstructive pulmonary disease (COPD) is a lung ailment that is characterized by a persistent blockage of airflow from the lungs. It is an under-diagnosed, life-threatening lung disease that interferes with normal breathing and is not fully reversible. The more familiar terms of chronic bronchitis and emphysema are no longer used; they are now included within the COPD diagnosis. [1] The Global Strategy, developed in direct response to the global threat posed by non-communicable diseases and endorsed by the Fifty-Third World Health Assembly, cites chronic respiratory disease (CRD) as one of the four prioritized disease groups to be addressed. [2] COPD is one of the most common disease among CRDs. [1]

Most countries do not have good population-based data on COPD prevalence[3], particularly among the middle-age and older population.[4] Till now there have not been any study conducted to estimate the national prevalence of COPDs in China, the most populous developing country in the world, particularly among the middle-age and older population.

More than 3 million people died of COPD in 2012, which is equal to 6% of all deaths globally that year and is the fourth leading cause of death worldwide. More than 90% of COPD deaths occur in low- and middle-income countries, such as China. [1]So far, estimated burden of COPD have been based primarily on mortality statistics. These provided figures are underestimated because COPD is under-diagnosed and is often not listed either as a primary or contributory cause of death.[4]

Multiple determinants serve to increase the burden of COPD. The direct and indirect exposure to tobacco smoke is the principal risk factor for the development of COPD.[4-6] In China, the prevalence of tobacco use in men is among the highest ones in the world, with more than 300 million smokers and 740 million non-smokers exposed to second-hand smoke.[7] Especially, the rapidly aging population, the percent of population over 60 years old increasing from 16·8% in 2015 to 45·4% in 2050 [8],

worsen the situation of higher burden of COPD in China. A previous study reported the prevalence of COPD in Nanjing, China was 5.9% among adults over 35 years old.[9] In 2002, Nanshan Zhong reported the prevalence rate of COPD among adults about 40 years old and over in seven provinces in China, which was about 8·2%.[10] Therefore, to estimate prevalence of COPD among middle-age and older Chinese adults from a more representative sample is urgently needed to better allocate health care resources in China. This is the first national population-based epidemiological study on COPD prevalence among middle-age and older in China.

Although tobacco use is identified as a risk factor of COPD,[4-6] more detailed risks of COPD among smoking population are unknown and the previous research population was small and region-specific[9,10], and thus national studies are deficient. Socio-economic development, environmental factors, life-style factors and healthcare utilization varied greatly among residents in different regions of China. Thus, a large regional variation of prevalence of COPD is expectable. To date, such data are lacking. Besides, there are many more risk factors needed to discover in order to develop cost-effective preventive strategies for COPD in China.

Therefore, aims of this study were to estimate the prevalence of COPD among middle-age and older Chinese adults nationally and to identify, quantify and confirm the risk factors associated with COPD using data from the China Health and Retirement Longitudinal Study (CHARLS).

Method

Study population

The CHARLS national baseline survey

The China Health and Retirement Longitudinal Study (CHARLS) is a national population-based survey conducted by the National School of Development of Peking University. Residents, aged at 45 or older, and their spouses, were interviewed at home and data on the social-economic and health status were collected using standardized questionnaire. The CHARLS baseline survey used a four-stage, stratified, cluster probability sampling design. [11] In the first stage, all counties in China were stratified by region, rural/urban status and per capita statistics on gross domestic product. A random sample of 150 counties was selected to represent the socio-economic and geographic pattern of all counties. In the second stage, three PSUs were selected in each county with the probability proportional to their

population size. In the third stage, all households in each selected PSU were mapped and a random sample of 24 households was selected among all households with residents aged ≥ 45 years within each PSU. Finally, for a selected household, one resident aged ≥ 45 years was randomly selected as a participant in the survey. If the spouse of the selected resident was also aged ≥ 45 years, the spouse was also included in the survey. The response rates were 80·51%, 94·15% and 68·63% among all eligible households, rural households and urban households, respectively. Overall, a total of 17314 individuals aged ≥ 45 years within 10257 households were interviewed in the baseline survey. [12] The detailed information of the CHARLS has been described in previous publications. [11] The response rate was 80·5% for the age-eligible households.

The CHARLS 2013 follow-up study

The CHARLS 2013 follow-up study carried out from July 2013 to August 2013 in order to follow up the disease status and relative factors in China. This survey was national study and was same as the 2011 baseline study. Among the unweighted COPD-free 15183 persons in the CHARLS baseline survey, 12655 (88·3%) ones were followed up in the 2013 CHARLS survey.

Data Collection

All participants had a face-to-face household-interview by the use of a structured questionnaire. Information collected in the household-interview included demographic factors (i.e., age, sex, living address), socioeconomic status (i.e., education, marital status) and medical history, healthcare situations, insurance status, employment status, retirement status, pension status, income status, expenditures status, assets status, etc. [11]

Health conditions

Information on COPD and other health conditions were self-reported. Responds were defined as having doctor-diagnosed COPD when they answered “yes” to the questions, “have you ever been told by a doctor or other health professional that you have chronic lung diseases, such as chronic bronchitis, emphysema (excluding tumors, or cancer)?” If the answer to either one is “Yes”, then the respondent was defined as COPD patient.

Respondents were also asked if they had been diagnosed with any of the following diseases: hypertension, dyslipidemia, diabetes, cancer (excluding minor skin cancers), liver diseases (excluding fatty liver, tumors, and cancer), heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems, stroke, kidney disease (excluding tumor or cancer), stomach or other digestive disease (excluding tumor or cancer), arthritis or rheumatism. Participants who answered yes to these questions were defined as having these doctor-diagnosed conditions. [12]

Smoking, drinking and sleeping

Information about lifestyle and health behavior was collected using a structured questionnaire. Drinking status was categorized into regular drinkers, occasional drinkers and non-drinkers. Smoking was categorized as ever-smokers and non-smokers.

Peak expiratory flow

The peak expiratory flow (PEF), also called peak expiratory flow rate (PEFR) is a person's maximum speed of expiration, as measured with a peak flow meter, a small, hand-held device used to monitor a person's ability to breathe out air. It measures the airflow through the bronchi and thus the degree of obstruction in the airways. Peak flow readings are higher when patients are well, and lower when the airways are constricted. Measurement of peak expiratory flow was with peak flow meter. Each patient performed the test in a standing position while holding the peak flow meter horizontally. Patients were instructed to take a deep breath then exhale by forceful expiration as fast as possible while maintaining an air tight seal between lip and mouth piece of the instrument with standard techniques. Technicians recorded readings only if the instrument was held in the proper horizontal position. The measurement of PEF repeated 3 times standing, and chose the maximum value as the effective value. [13]

Statistical analysis

We divided subjects' age into four groups: 45-49, 50-59, 60-69 and ≥70 years old, and categorized their living localities into six areas, East (7 provinces: Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Anhui, Jiangxi), North (two cities: Beijing and Tianjin and 3 provinces : Hebei, Shanxi and Inner Mongolia), North-East (three provinces: Liaoning, Jilin and Heilongjiang), North-West (four provinces: Shaanxi, Gansu, Qinghai and Xinjiang), South-Central (five provinces: Henan, Hubei, Hunan,

Guangdong and Guangxi), and South-West (One city: Chongqing and three provinces: Sichuan, Guizhou and Yunnan). Individuals living in Tibet, Hong Kong, Macau and Taiwan were not included in this survey. Participants were classified as urban or rural residents in the survey. Sleep duration was categorized into five levels, ≤4 hours, 4·1-6 hours, 6·1 -7 hours, 7·1-9 hours and ≥ 9·1 hours. Education level was divided into four categories: no formal education, elementary school, middle/high school, and college or higher education. Living standard and childhood health were categorized into Good, Fair and poor levels.

The prevalence of COPD was analyzed with taking into account the complex survey design and non-response rate. The inverse probability weighting method was used to account for different response rates. We used Stata 13.1 (StataCorp LP, College Park, TX, USA) Survey data analysis procedure to calculate the overall and sex-specific prevalence of COPD according to strata of each risk factors. We used Survey Logistic procedure in Stata to examine the association of each risk factors with the prevalence of COPD with the adjustment of other potential confounders, including age, gender, province, area, smoking, drinking, sleeping, childhood health and other diseases.

Both procedures took into account the complex survey designs and non-response rate of CHARLS survey, when estimating the prevalence, prevalence odds ratio and confidence intervals. The CHARLS consisted of approximately 17000 participants aged at 45 or older; thus it would allow us to estimate the prevalence of COPD with high precision and have adequate data to detect a small effect estimate.

To confirm the risk factor of COPD, we conducted a longitudinal analysis. Follow up the baseline 15183 COPD-free participants and check the disease status after 2-year follow-up period.

All the analyses were conducted with respect to the complex survey design and non-response rate. Results are presented as percent or odds ration(OR), relative risk(RR) and 95% confidence interval(CI); P-values < 0·05 were considered significant.

And we use ArcGIS Desktop 10.1 for mapping the region-specific prevalence rate of COPD.

Results

Prevalence rate of COPD

There were 17708 residents (10069 main respondents and 7639 spouses) participating in the CHARLS baseline survey between June 2011 and March 2012. When combining datasets, three persons were lost due to demographic information, 111 persons were lost due to health-related information, 97 were lost due to COPD outcomes, 394 persons were lost due to less than 45 years old and 153 persons were lost due to living standards information and 12 persons were lost due to gender information. 16938 residents were included into the analysis. The respondents had a mean age of 59·6 years (95% CI: 59·35-59·84), and 48·31% (8183/16938) were males and 50.66% (8581/16938) of the participants were living in the rural areas. The majority of participants only received elementary school education. The overall prevalence rate of COPD is 10·11% (95% CI: 9·50% 10·76%).

The region-specific prevalence rates of COPD were displayed in Figure 2. There were significant differences among different areas in China. Residents in North-West had the highest prevalence rate of COPD (15.30%). The South-Central had the lowest prevalence rate of COPD.

Characteristics of COPD

The median of PEF between COPD group and non-COPD group were different significantly (*P< 0.001,* using Wilcoxon Rank Sum Test). The PEF of COPD and non-COPD were 200 and 300 respectively. As shown in Table 1 and Figure 1, the differences between COPD and non-COPD were significantly at each age group. The differences between COPD and non-COPD among different age groups were 30,70,60,80,60,50,70 and 40 ml.

Univariate analysis

As shown in Table 2, the prevalence rate of COPD was associated with age, gender, province, area, smoke, drinking alcohol, sleep duration, education, marital status, pension, living standard, childhood health, heart problems, liver disease, kidney disease and arthritis significantly. The prevalence rate of COPD between different age groups were different. The older had higher prevalence rates, particularly equal to or greater than 60 years old and the P for trend is 0·002. And males had higher prevalence rate, 11·67% to 8·65%.

Multivariable logistic

The logistic modeling results were shown in Table 3. Model 1 adjusted gender and age variables and Model 2 adjusted all the relative variables.

The prevalence rate of COPD was higher in the group of participants aged at 60 or older and was lower in the group aged at less than 60 years old.

And the South-west (PR 16·48 CI: 14·03-19·25) and North-west (PR 15·08 CI:13·66-16·61) had higher COPD prevalence rates than South-central as shown in Figure 2. In addition, the prevalence rates of provinces were shown in Figure 3.

Smoking was associated with the prevalence rate of COPD strongly and the odds ratio was 1·88 (95% CI 1·53-2·30). Participants drinking alcohol more than once per month had higher risk of COPD than those never drinking alcohol. Besides, participants with sleep duration from 4.1 to 6 hours and less than 4 hours had higher risk of COPD. Participants having heart problems, liver diseases, kidney disease and arthritis had higher prevalence rate of COPD.

Incidence rate of COPD

Among the unweighted COPD-free 15183 persons in the CHARLS baseline survey, 12655 (88·3%) ones were followed up in the 2013 CHARLS survey. The incidence rate of COPD from 2011 to 2013 was 1.87% after weighting according to complex sample design and non-response rate in 2-year follow-up period.

As shown in Table 4, gender, province variable, area variable, smoking, living standard, heart problems, liver disease and kidney disease were confirmed to be risk factors of COPD in the longitudinal analysis.

Discussion

The overall prevalence rate of COPD was 10·11% after weighting. There were fewer studies estimating the prevalence rate of COPD. In 2002, Nanshan Zhong reported the prevalence rate of COPD among adults about 40 years old and over in seven provinces in China, which was about 8·2%.[10] Reason of the relative low prevalence rate may be that the study was conducted in seven east and central regions of China with relative low prevalence rate. Besides, the Nanshan Zhong's study focused on the population ≥ 40 years old younger than our study, which may also reason of this relative low prevalence rate.

There was a remarkable variation in prevalence of COPD in terms of geographic location, with residents living in the South-west region and North-west having much higher prevalence of COPD than residents from other parts of China. The reason may be that South-west region and North-west had relatively worse healthcare service and the patients' acute pulmonary diseases cannot be treated reasonably. This would help plan the targeted control strategies.

The prevalence rate of COPD was higher in the rural than the urban, which may be due to the more biomass exposure, and poor living, work and healthcare conditions. The males had higher prevalence rate and incidence rate than the females adjusted smoking status, consistent with previous study. [10,17]

And the median of PEF between COPD group and non-COPD group were different, which suggests us screening COPD using PEFR.[14] In general, FEV measurements by spirometry are preferred as it is much more reproducible.[15] However, spirometry is not widely available, and the technical pitfalls of performing spirometry frequently limit usage, especially at a primary care level.[16] Using PEFR measurement is more economical and much more widely available, therefore it is proposed as an alternative to spirometry. [13]

The odds ratio (OR) of smoking associated with COPD is 1·67 (95% CI :1·39-2·01) with adjustment of all the relative variables. And the relative risk of smoking group was 1·73. So the smoking is a risk factor of COPD in China, which is consistent with previous studies. [4-6,17]

Sleep duration was associated with COPD in the cross-sectional analysis, but in the longitudinal study the association between them was not significantly. The reason may be that the COPD cause the sleeping problem, which suggested that COPD could cause sleeping problems. [18]

Education had no influence on prevalence of COPD, though in other studies, education had effect on the prevalence of other diseases, such as symptomatic knee osteoarthritis. [19]

In the cross-sectional study, the childhood health was associated with COPD but not confirmed in the longitudinal study. This may be due to the recall bias, because the child health status was asked retrospectively. The patients had inclination to recall the childhood health as poor condition. [20]

Participants having heart problems had higher risk of COPD and confirmed in the longitudinal study. According to previous study, COPD would lead to the increased right heart load in COPD and left ventricle wall stress [21], this study proves that heart problems contribute to the onset of COPD.

In the present study, liver disease is a risk factor confirmed in the longitudinal study. Yoshiaki Minakata's study[22] had shown that patients with liver disease had a significantly higher prevalence of COPD when the odd ration was adjusted by the amount of smoking and age. The reason why the patients with liver disease had higher prevalence of COPD is not clear. But there is a possibility that nitric oxide is the key molecule in the pathogenesis of COPD[23]. It has been reported that the exhaled NO level is increased in liver cirrhosis[24,25], and the expression of pulmonary vascular NO synthase is increased in hepatopulmonary syndrome[26-28]. Though the liver disease-induced NO, which is derived from pulmonary endothelium, is different from inflammatory cells or epithelium, circulating NO metabolites such as S-nitrosoglutathione may be related to the development of COPD. Further study is necessary to clarify the relationship between liver disease and the development of COPD[22].

Another risk factor of COPD confirmed in this study is kidney disease. Takayuki Yoshizawa's study [29] showed that kidney disease was associated with COPD. Still, further study is needed to interpret the reason why kidney disease is the risk factor of COPD.

Our study has several advantages. The CHARLS was a national survey targeted at middle-aged and older adults. The study participants were sampled through a strict multistage probability sampling, with valid quality control when conducting the survey. The respondent rate was as high as 80·1%. And the non-response rate was adjusted using reverse probability weighting. Thus, the nature of data enables us to describe the nationwide prevalence rate of COPD. In addition, previous studies indicated that the smoking was a risk of COPD, but the odds ratio or risk ratio was region-specific and crude. This study enables us to estimate nationwide odds ratio precisely in China. What's more, we found many more important and unique potential risk factors such as living standard, heart diseases, liver diseases and kidney disease, which are interesting and important risk factors. These findings are helpful in screening COPD patients. Particularly, there are only about 30% detection rate of COPD [10,30].

Our study has some limitations as well. First, the diagnosis of COPD was based on self-report by participants themselves, and thus was lack of diagnosis from doctors in field, which may lower the prevalence rate of COPD. However, this is a national-wide research, the diagnosis of COPD would be not practical and money-consuming if efforts from professional doctors were demanded.

And the sample size was population-size based, so in the west part of China, which has fewer population, estimated the prevalence rate crudely. Moreover, because of the fewer healthcare resources provided in the west, self-reported prevalence rate may be underestimated. However, considering that prevalence rate of COPD has been high so far, the real difference in COPD prevalence rate could be even higher than what has been reported here. Finally, though the COPD were a group of chronic respiratory diseases rather than only one definite disease, the COPD prevalence rate can represent the overall chronic respiratory burdens to some extent.

In conclusion, this study estimated that 10·11% of Chinese adults ≥ 45 years old reported having COPD overall. The prevalence and incidence rates of COPD increased with increasing age and males had higher prevalence and incidence rates. In addition, the western part of China had higher prevalence and incidence rate. Except for smoking, heart disease, liver diseases and kidney disease may be novel risk factor for COPD.

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Table 1 The median peak expiratory flow of CRDs and non-CRDs participants among different age groups.

Age group	COPD(ml)	Non-COPD(ml)	*P*-Value
45-49	300	330	<0.001
50-54	260	330	<0.001
55-59	250	310	<0.001
60-64	200	280	<0.001
65-69	170	260	<0.001
70-74	130	220	<0.001
75-79	130	200	<0.001
≥80	150	170	0.001

Table 2 The characteristics and prevalence rates of the participants in the China Health and Retirement Longitudinal Study(CHARLS) 2011national baseline survey.

Characteristics	Percent (%)	Prevalence Rate (%)	*P*-Value
Age group			<0.001[T]
45-49	21.47	6.95(5.58-8.63)	
50-59	34.59	6.77(6.12-7.48)	
60-69	25.41	12.13(10.84-13.55)	
≥70	18.52	17.24(15.54-19.08)	
Gender			<0.001
Male	48.32	11.67(10.73-12.67)	
Female	51.68	8.65(7.87-9.51)	
Province			<0.001
South-Central	26.94	8.45(7.02-10.14)	
East	30.23	8.83(7.90-9.86)	
North	11.88	9.15(7.90-10.58)	
North-East	8.02	11.63(9.74-13.84)	
South-West	15.57	12.96(11.64-14.39)	
North-West	7.37	15.30(12.93-18.02)	
Area			
Rural	50.66	11.09(11.91-13.34)	
Urban	49.34	9.10(9.17-11.39)	0.003
Smoking			<0.001
Yes	39.31	13.07(12.00-14.22)	
No	60.68	8.20(7.48-8.98)	
Drinking Alcohol			<0.001[T]
≥1 /month	7.80	18.30(15.58-21.36)	
< 1 /month	11.63	9.94(8.19-12.02)	
Never	80.57	9.43(8.62-10.32)	
Sleep duration			<0.001
≤4h	26.32	16.40(14.28-18.77)	
4.1-6h	19.52	10.66(9.50-11.96)	
6.1-7h	34.41	8.27(7.09-9.63)	
7.1-9h	15.64	7.92(7.00-8.96)	
≥9.1	4.11	9.84(7.60-12.65)	

Table 2 continued.

Characteristics	Percent(%)	Prevalence Rate(%)	*P*-Value
Education			<0.001[T]
No formal education	42.76	11.54(10.72-12.40)	
Elementary School	21.05	11.46(9.88-13.25)	
Middle/High School	32.80	7.75(6.70.42-8.93)	
College or higher	3.39	6.83(4.42-10.42)	
Marital status			<0.001[T]
Married	85.18	9.50(8.85-10.20)	
Divorced	13.76	13.25(11.51-15.20)	
Never married	1.06	18.06(11.82-26.59)	
No pension			<0.001
Yes	20.3	5.67(4.79-6.71)	
No	79.7	11.26(10.54-12.03)	
Living Standard			<0.001[T]
Good	3.27	7.24(4.94-10.49)	
Fair	53.52	9.31(8.58-10.11)	
Poor	43.21	11.84(10.69-11.03)	
Childhood Health			<0.001[T]
Good	76.67	9.32(8.66-10.02)	
Fair	16.62	11.95(10.51-13.56)	
Poor	6.71	15.60(12.00-20.03)	
Heart Problems			<0.001
Yes	11.85	20.90(18.34-23.71)	
No	88.15	8.59(8.01-9.21)	
Liver Disease			<0.001
Yes	3.96	24.67(18.91-31.50)	
No	96.04	9.42(8.85-10.02)	
Kidney Disease			<0.001
Yes	6.18	18.72(15.94-21.85)	
No	93.82	9.45(8.83-10.12)	
Arthritis			<0.001
Yes	31.54	15.11(13.70-16.64)	
No	68.46	7.77(7.19-8.40)	

T means *P*-Value for trend less than 0.05 using Cochran-Armitage trend test

Table 3 The odds ratios(OR) of risk factors of CRDs by multivariable logistics regression in the China Health and Retirement Longitudinal Study(CHARLS) 2011 baseline survey.

Characteristics	Model 1 (Adjusted gender & age)	Model 2 (Adjusted all variables)
Age group		
45-50	1.00(reference)	1.00(reference)
51-60	0.96(0.75-1.25)	0.68(0.50-0.95)
61-69	**1.82(1.40-2.38)**	1.03(0.74-1.44)
≥70	**2.79(2.14-3.62)**	**1.63(1.15-2.31)**
Gender		
Male	**1.40(1.21-1.61)**	**1.40(1.11-1.77)**
Female	1.00(reference)	1.00(reference)
Province		
South-Central	1.00(reference)	1.00(reference)
East	1.02(0.81-1.29)	0.84(0.65-1.09)
North	1.08(0.84-1.40)	0.90(0.67-1.20)
North-East	**1.42(1.07-1.89)**	1.03(0.73-1.45)
South-West	**1.55(1.22-1.96)**	1.18(0.90-1.54)
North-West	**1.87(1.41-2.50)**	**1.74(1.26-2.40)**
Area		
Rural	0.82(0.71-0.95)	1.06(0.88-1.27)
Urban	1.00(reference)	1.00(reference)
Smoking	**1.67(1.39-2.01)**	**1.64(1.32-2.04)**
Drinking Alcohol		
≥1 /month	**1.63(1.28-2.08)**	**1.38(1.13-1.86)**
< 1 /month	0.97(0.75-1.25)	0.94(0.71-1.24)
Never	1.00(reference)	1.00(reference)
Sleep duration		
≤4h	**2.14(1.73-2.65)**	**1.77(1.41-2.23)**
4.1-6h	**1.40(1.15-1.69)**	**1.46(1.17-1.83)**
6.1-7h	1.10(0.89-1.37)	1.25(0.97-1.62)
7.1-9h	1.00(reference)	1.00(reference)
≥9.1h	1.19(0.87-1.64)	1.43(0.99-2.09)

Table 3 continued.

Characteristics	Model 1	Model 2
Education		
No formal education	**1.70(1.08-2.69)**	1.34(0.74-2.44)
Elementary School	**1.70(1.07-2.73)**	1.36(0.74-2.48)
Middle/High School	1.30(0.82-2.08)	1.13(0.62-2.03)
College and over	1.00(reference)	1.00(reference)
Marital status		
Married	1.00(reference)	1.00(reference)
Divorced	1.05(0.87-1.26)	0.96(0.77-1.20)
Never married	**1.83(1.09-3.07)**	1.01(0.50-2.05)
No pension	**1.71(1.38-2.12)**	**1.46(1.06-2.02)**
Living Standard		
Good	1.00(reference)	1.00(reference)
Fair	1.52(0.99-2.33)	1.30(0.79-2.16)
Poor	**2.04(1.33-3.15)**	1.46(0.87-2.43)
Childhood Health		
Good	1.00(reference)	1.00(reference)
Fair	**1.37(1.16-1.61)**	1.15(0.94-1.39)
Poor	**1.90(1.39-2.59)**	**1.45(1.07-1.97)**
Heart Problems	**2.57(2.15-3.08)**	**2.22(1.83-2.70)**
Liver Disease	**2.18(2.32-4.46)**	**2.17(1.47-3.22)**
Kidney Disease	**2.20(1.80-2.68)**	**1.40(1.08-1.81)**
Arthritis	**2.10(1.81-2.43)**	**1.63(1.35-1.98)**

Bold text represents significant variables.

Table 4 The baseline characteristics of COPD-free participants in the 2011 national baseline study by status in the national follow-up of 2013 and incidence rates of the national 2013 follow-up study.

Characteristics	Percent (%)	Incidence Rate (%)	Relative Rate (%)	*P*-Value
Age group				0.112
45-49	21.35	1.40(0.97-2.02)	1.00(reference)	
50-59	36.34	1.72(1.35-2.18)	1.23	
60-69	25.88	2.24(1.75-2.86)	1.60	
≥70	16.43	2.25(1.59-3.14)	1.60	
Gender				**0.002**
Male	53.05	2.31(1.91-2.79)	1.56	
Female	46.95	1.48(1.20-1.83)	1.00(reference)	
Province				**0.003**
South-Central	27.02	1.64(1.22-2.20)	1.00(reference)	
East	30.60	1.28(0.94-1.75)	0.78	
North	12.27	1.89(1.25-2.82)	1.15	
North-East	7.87	2.50(1.51-4.10)	1.52	
South-West	15.43	2.94(2.27-3.81)	1.79	
North-West	6.81	2.25(1.39-3.62)	1.37	
Area				**0.003**
Rural	54.11	2.20(1.86-2.60)	1.49	
Urban	45.89	1.48(1.15-1.92)	1.00(reference)	
Smoking				**<0.001**
Yes	62.39	2.54(2.07-3.11)	1.73	
No	37.61	1.47(1.21-1.79)	1.00(reference)	
Drinking Alcohol				0.900
≥1 /month	6.77	1.65(0.94-2.19)	0.88	
< 1 /month	11.39	1.78(1.11-2.84)	0.95	
Never	81.83	1.88(1.56-2.26)	1.00(reference)	
Sleep duration				0.1936
≤4h	14.60	2.30(1.65-3.19)	1.51	
4.1-6h	34.67	2.14(1.66-2.75)	1.41	
6.1-7h	19.75	1.55(1.11-2.16)	1.02	
7.1-9h	26.96	1.52(1.12-2.05)	1.00(reference)	
≥9.1	4.03	2.04(1.12-3.68)	1.34	

Table 4 continued.

Characteristics	Percent (%)	Incidence Rate (%)	Relative Risk (%)	*P*-Value
Education				0.321
No formal education	43.18	1.97(0.77-4.99)	1.00(reference)	
Elementary School	21.54	1.56(1.19-2.05)	0.79	
Middle/High School	32.51	2.29(1.74-3.02)	1.16	
College or higher	2.77	1.89(1.53-2.34)	0.96	
Marital status				0.794
Married	86.35	1.84(1.58-2.14)	1.00(reference)	
Divorced	12.72	2.02(1.34-3.05)	1.10	
Never married	0.92	2.44(0.88-6.58)	1.33	
Pension				0.084
Yes	19.34	1.35(0.89-2.04)	0.68	
No	80.66	1.98(1.71-2.31)		
Living Standard				**0.002**
Good	43.04	0.82(0.33-2.04)	1.00(reference)	
Fair	53.68	1.50(1.20-1.87)	1.83	
Poor	3.28	2.31(1.90-2.82)	2.82	
Childhood Health				0.579
Good	77.28	1.80(1.53-2.12)	1.00(reference)	
Fair	16.13	2.17(1.52-3.08)	1.21	
Poor	6.59	1.81(1.12-2.91)	1.01	
Heart Problems				**0.034**
Yes	10.12	2.81(1.87-4.19)	1.60	
No	89.88	1.76(1.52-2.05)	1.00(reference)	
Liver Disease				**0.002**
Yes	3.37	4.15(2.46-6.91)	2.32	
No	96.63	1.79(1.54-2.07)	1.00(reference)	
Kidney Disease				**0.050**
Yes	5.77	2.87(15.94-21.85)	1.59	
No	94.23	1.80(1.55-2.10)		
Arthritis				0.196
Yes	30.09	2.13(1.71-2.65)	1.21	
No	69.91	1.76(1.47-2.12)	1.00(reference)	

Bold text represents significant variables.

Figures

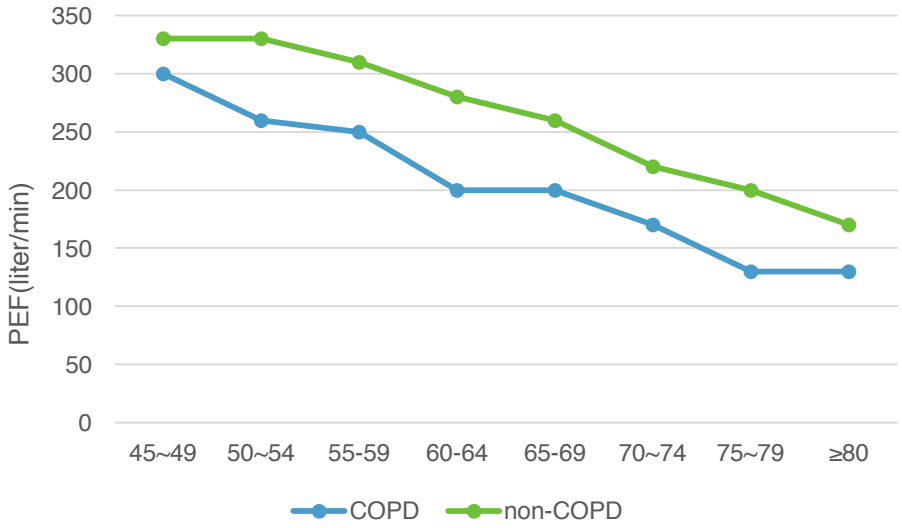

Figure 1 The median peak expiratory flow of COPD and non-COPD participants among different age groups.

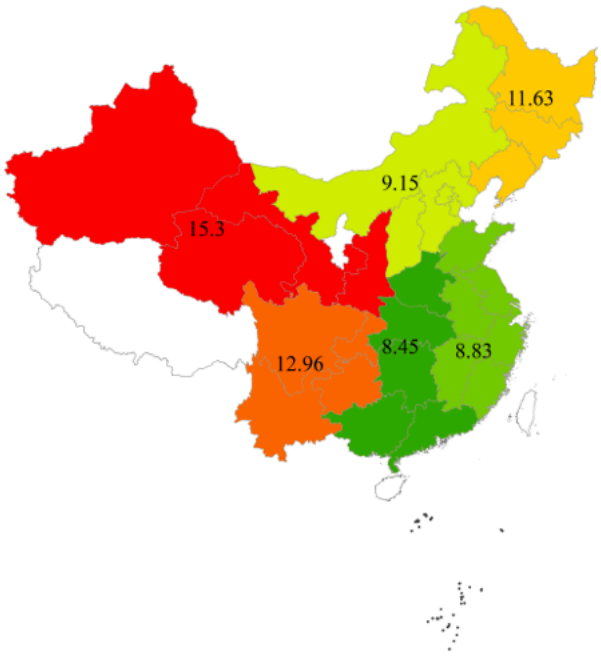

Figure 2 The prevalence rate of COPD in different regions.