

# BMJ Open Cross-sectional survey on cigarette smoking in Chinese high-income areas

Lei Yuan ,<sup>1</sup> Pei Liu,<sup>2</sup> Zhe Zhao,<sup>1</sup> Zhenbang Wei,<sup>1</sup> Lijuan Liu,<sup>1</sup> Jinhai Sun<sup>1</sup>

**To cite:** Yuan L, Liu P, Zhao Z, et al. Cross-sectional survey on cigarette smoking in Chinese high-income areas. *BMJ Open* 2022;**12**:e056209. doi:10.1136/bmjopen-2021-056209

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-056209>).

LY, PL and ZZ contributed equally.

Received 17 August 2021  
Accepted 08 April 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Department of Health Management, Second Military Medical University, Shanghai, People's Republic of China  
<sup>2</sup>Department of Mathematics and Physics, Second Military Medical University, Shanghai, People's Republic of China

## Correspondence to

Lei Yuan; [yuanleigz@163.com](mailto:yuanleigz@163.com),  
Lijuan Liu;  
[liulijuan79@sina.com](mailto:liulijuan79@sina.com) and  
Jinhai Sun;  
[sunjinhai2003@sina.com](mailto:sunjinhai2003@sina.com)

## ABSTRACT

**Objective** To evaluate smoking status and its influencing factors in high-income areas of China.

**Design** Cross-sectional.

**Setting** High-income areas in China.

**Participants** 4064 persons aged 15 years or older from the survey results in *Global Adult Tobacco Survey-China 2018*.

**Methods** Gross national income data were used to determine China's high-income economic regions, and the results of the survey in *Global Adult Tobacco Survey-China 2018* were used for statistical analysis.

**Results** A total of 4064 people were included in our study, including 881 current smokers, 2884 who had never smoked and 299 who had quit smoking. Using the standardised rate method, the standardised smoking rates in high-income and non-high-income areas in China were calculated to be 23.56% and 27.77%, respectively. Men, high school education or below, knowledge of e-cigarette information, permission to smoke at home and people with poor smoking health literacy are the main influencing factors of smokers in high-income areas of China.

**Conclusion** The smoking rate of people in China's high-income areas is lower than the overall smoking rate in China, and we should increase the public awareness that smoking is harmful to health, encourage the prohibition of smoking at home, increase investment in higher education and improve residents' smoking health literacy level. The purpose of this study was to encourage reduction in the rate of smoking and better control the prevalence of smoking.

## INTRODUCTION

Smoking is the main cause of chronic non-communicable diseases worldwide, and it is also an important risk factor for cardiovascular diseases and lung diseases.<sup>1</sup> In 2019, as the second largest health risk factor in the world, smoking caused 8.71 million deaths, accounting for 15.4% of the annual deaths.<sup>2</sup> As a major tobacco producer and consumer in the world, China is at the centre of this health crisis.<sup>3</sup> The results of the 2018 Chinese Adult Tobacco Survey released by the Chinese Center for Disease Control and Prevention (CCDC) show that the smoking rate of people aged 15 and over in China is 26.6%, including 50.5% for men and 2.1% for women.<sup>4</sup> Although the overall rate is lower than in the previous survey (28.1% in

## Strengths and limitations of this study

- ⇒ To the best of our knowledge, this study is the first nationwide study to analyse the prevalence of smoking in all high-income areas in China.
- ⇒ The research data come from the public data surveyed by the National Center for Disease Control and Prevention, which is highly representative.
- ⇒ Due to the limited sample size, there may be some deviations between the research results and the actual results.
- ⇒ Smoking prevalence is based on self-reporting by the participants and may be affected by recall bias.

2010), the number of people who smoke is still high compared with the global smoking rate of 19.2%.<sup>4 5</sup>

Previous studies have shown that exposure and use of tobacco products are related to regional income levels.<sup>6</sup> Compared with developed countries, the smoking rate of people in developing countries is often higher, and national economic development is one of the main factors influencing smoking prevalence.<sup>7</sup> Several studies on smoking prevalence have found that people with low income have a stronger response to tobacco prices than people with high income.<sup>8–10</sup> Other studies found no evidence of this difference.<sup>11 12</sup> In the past three decades, China's economy has developed rapidly, and the national income of some regions has reached the standard of developed regions worldwide and has entered the ranks of high-income areas. Control of the tobacco epidemic is a long-term process, which is strongly related to the residents' education, culture, health literacy, behaviour, cognition, family income and mental health.<sup>13 14</sup> In recent decades, some cities in China have seen rapid growth in industrialisation and modernisation and have become areas of higher economic levels. However, there is a lag in changes related to smoking intensity pattern, social and economic group composition, the tobacco epidemic trend and other factors that are different from those in developed countries.<sup>15</sup> The process



of controlling the tobacco epidemic needs to be different from that used in developed countries; however, there are no studies on this yet. Therefore, it is necessary to analyse the characteristics of smoking behaviour in high-income areas of China to provide suggestions for developing countries to improve the control of the tobacco epidemic while undergoing rapid economic growth.

## METHODS

### Definition and selection of high-income regions in China

According to the per-capita gross domestic product (GDP) of China's provinces in 2018 published in the *2019 China Statistical Yearbook*, and according to the economic division standard of high-income countries by the World Bank (gross national income (GNI) >\$12 055, on average \$1 equalled ¥6.6118 in 2018).<sup>16</sup> Since only the GDP, and not the GNI value, is mentioned for each region of China, the regional GDP value is used to calculate the regional GNI value. The formula used for conversion is:

$$\text{Regional GNI} = \text{Regional GDP} / \left( \frac{\text{National GDP}}{\text{National GNI}} \right)$$

According to the formula, the provinces with regional GNI that meet high-income regional standards are Beijing (\$23 125), Tianjin (\$18 188), Shanghai (\$20 338), Jiangsu (\$17 353), Zhejiang (\$14 863), Fujian (\$13 741) and Guangdong (\$13 020).

### Data sources

The research data come from the Global Adult Tobacco Survey (GATS)-China 2018, which was a multistage stratified cluster sample sampling survey conducted by the CCDC in 2018, and 19 376 people were selected for interview survey.<sup>17</sup> The detailed design report is available here: <https://nccd.cdc.gov/GTSSDataSurveyResources/Ancillary/Publications.aspx> (accessed 5 Jan 2022). The inclusion criteria included living in China's high-income provinces and age above 15. The data of 4851 respondents belonged to high-income areas. The exclusion criteria included no response to any item in the survey and/or no response to smoking knowledge and/or no response to smoking attitude. A total of 4064 respondents were selected for this study.

### Smoking classification

This study divided participants into three categories: 881 current smokers (smokers at the time of the survey), 2884 people who had smoked (never smokers) and 299 people who had quit smoking (quit smokers).

### Analytical index

#### Demographic data

All participants provided the following demographic data: sex, age, province, residence attributes (urban and rural), education level (no formal education, below primary school, below junior high school, junior high school, high school, university, postgraduate, above), annual family income, occupation (agriculture, forestry,

animal husbandry, government civil servants, business administration, factory workers, teachers, health workers, students, soldier, no job, retired, other employment statuses), number of family members, number of family members 15 years and older, workplace (indoor and outdoor), family smoking regulations (allowed, generally not allowed but with exceptions, never allowed, no regulations) and knowledge about electronic cigarettes.

### Smoking cessation

The smoking cessation of current 881 smokers was investigated through seven questions, including:

1. Have you ever tried to stop smoking? ('Yes' or 'No').
2. Which of the following best describes your thinking about quitting smoking? ('Quit within the next month', 'Thinking within the next 12 months', 'Quit someday, but not in 12 months', 'Not interested in quitting', 'Don't Know', 'Refuse/Missing').
3. What was the most important reason for you to try to stop smoking last time? ('Got illness', 'Worried about self-health', 'Heavy economic burden', 'Family's disapproval', 'Other').
4. Thinking about the last time you tried to quit, how long did you stop smoking? ('Months', 'Weeks', 'Days', 'Less than one day 24 hours').
5. During any visit to a doctor or healthcare provider in the past 12 months, were you asked if you smoke tobacco? ('Yes' or 'No').
6. During any visit to a doctor or healthcare provider in the past 12 months, were you advised to quit smoking tobacco? ('Yes' or 'No').
7. Have the warnings on cigarette packs made you think about quitting? ('Yes', 'No' or 'No attention paid').

### Knowledge of smoking

All participants were provided a 12-item questionnaire to evaluate smoking knowledge, including statements on smoking and the relationship between smoking and the consequences such as specific diseases. The specific questions have been shown in online supplemental table S1. Each question was scored 1 point for correct answers and 0 point for incorrect answers. The score was calculated according to ref 18.

Questions for knowledge judgement evaluated the knowledge of smoking in the survey population. The scores of 1–4 indicated 'poor smoking knowledge', 5–8 indicated 'fair' and 9–12 demonstrated 'good'.

### Attitude towards smoking

The attitude towards smoking was evaluated through five questions, including:

1. Do you pay attention to health warnings on the cigarette case? ('Yes', 'No' or 'Uncertain').
2. Do you agree with having health warning pictures printed on cigarette packs? ('Yes', 'No' or 'Uncertain').
3. Do you agree with increasing the tobacco tax and retail price of cigarettes? ('Yes', 'No' or 'Uncertain').

4. If the tobacco tax increases, should part of the funds be used for tobacco control? ('Yes', 'No' or 'Uncertain').
5. If the tobacco tax is increased, do you think that part of the funds should be used for health insurance? ('Yes', 'No' or 'Uncertain').

### Statistical method

The SPSS Statistics V.21.0 (IBM) software was used for statistical analysis. Descriptive statistical method was used to describe demographic data and the proportion of answers that varied in the questionnaires, among different groups; we used the standardised rate method to calculate smoking prevalence in high-income areas based on population adjustments;  $\chi^2$  test was used to analyse the univariate analyses of smokers and quit smokers, the test standard was  $\alpha=0.05$ .

We selected current smokers and never smokers as evaluation variables using stepwise regression analysis established to evaluate the influence of different variables on smoking and quitting status (including  $\alpha=0.05$ , excluding  $\alpha=0.10$ ), the bilateral test ( $p<0.05$ ) was considered statistically significant.

### Patient and public involvement

No participants were involved in deciding the research question, study design, outcome measures or interpretation of results. This study uses data provided through a survey by the participants and were securely accessed and stored. There are no plans to disseminate the results of the research to the study participants. No permission was required for accessing and using these data.

## RESULTS

### Demographic data

The demographic data of the survey respondents are shown in [table 1](#). The results of the study were based on 881 smokers, 2884 never smokers and 299 quit smokers.

The population aged 15 years and over in China's high-income areas was calculated according to the sampling results of China's population in 2018 surveyed by the *China Statistical Yearbook* in 2019. According to the results of the smoking sampling survey, the total smoking rate in the survey area was 30.75%, of which 44.52% were men and 1.62% were women (online supplemental table S2). Using the standardised rate method and based on the total population of China and officially announced smoking rate in 2018, the standardised smoking rate in high-income areas was 23.56% while that in non-high-income areas was 27.77%.

### Current smokers

The current tobacco usage activities of smokers are shown in [table 2](#). According to the survey, current smokers often smoked their first cigarette 6–30 min after waking up in the morning and like to buy packaged cigarettes. The cost of buying cigarettes every time was mostly below ¥100,

they often bought cigarettes in supermarkets and did not use smokeless tobacco.

### Smoking cessation

Among the current smokers, 364 people (41.32%) had tried to quit smoking, and more than half of the smokers (63.22%) were unwilling to quit smoking ([table 3](#)). Among the people who tried to quit smoking, the main reason for quitting was health (either they got ill or worried about their health). Most of the people who answered the last smoking cessation situation persisted on quitting smoking for several months. The data were got by question D02A in the GATS. The investigation which was carried out by questions B16 and B17 in the GATS showed that 54.57% of people were asked about their treatment by doctors and 73.60% of patients who had asked about smoking had been advised to quit (D02A, B16 and B17 in online supplemental table S3). Only a small number of people (24.08%) thought that the warnings on the cigarette packs were useful, while most thought they were useless or paid no attention to them.

### Knowledge of and attitude on smoking

Questions 1–12 are based on knowledge of smoking ([table 4](#)). There are seven questions with the correct answer rate exceeding 50%. Many people do not have the knowledge of the harm caused by smoking or by second-hand smoke in relation to stroke, heart disease, erectile dysfunction and heart disease in adults.

### Smoking knowledge scores

The scores based on knowledge of smoking for 918 people (22.59%) were evaluated as poor and for 1445 people (36.48%) as good ([table 5](#)). After analysis, there were significant differences in smoking scores among current smokers, never smokers and quit smokers ( $p<0.001$ ).

### Factors associated with smoking

There are 12 input variables: the factors with  $p<0.05$ , as shown in [table 1](#), and smoking knowledge scores were selected as input variables, the current smoking status was taken as the output variable and a binary logistic model was established ([table 6](#)). The results of stepwise regression analysis show that five variables are the influencing factors of smoking in high-income areas: sex, education level, e-cigarette knowledge, smoking rules at home and smoking knowledge.

## DISCUSSION

To the best of our knowledge, this study is the first to examine the prevalence of smoking among people in high-income areas in China. It evaluates smoking knowledge and attitudes towards smoking, and analyses the main influencing factors of smoking among people in high-income areas. The regional formulation of tobacco control policies provides good theoretical support.

However, the smoking rate in China is still higher than the global average. The results of our analysis show that

**Table 1** Basic information

Characteristics		Current smoker	Never smoker	Former smoker	X <sup>2</sup>	P value
Province	Beijing	33	144	14	48.55	<0.001
	Tianjin	20	50	8		
	Shanghai	109	336	44		
	Jiangsu	260	582	80		
	Zhejiang	130	582	80		
	Fujian	22	42	2		
	Guangdong	307	1003	68		
Gender	Male	859	736	279	1696.55	<0.001
	Female	22	2148	20		
Age	15–19	6	63	2	181.74	<0.001
	20–29	95	359	6		
	30–39	95	506	15		
	40–49	156	498	28		
	50–59	198	504	50		
	≥60	331	954	198		
Urban-rural indicator	Urban	636	2195	203	13.28	0.001
	Rural	245	689	96		
Education level	No formal schooling	28	321	17	168.44	<0.001
	Less than primary school completed	99	259	42		
	Primary school completed	116	304	40		
	Less than secondary school completed	45	98	22		
	Secondary school completed	286	640	70		
	High school completed	178	484	59		
	College/university completed	125	719	48		
	Postgraduate degree completed	4	59	1		
Profession	Agriculture, forestry, animal husbandry	147	378	46	159.12	<0.001
	Government employee	33	118	5		
	Factory, business, service industry employee	296	857	65		
	Teacher	5	62	1		
	Healthcare provider	3	56	2		
	Student	1	64	1		
	Soldier	1	2	1		
	No job	39	278	23		
	Retired	168	649	119		
	Other	188	420	36		
Number of persons who live in this household	1	164	463	56	33.42	<0.001
	2	290	927	128		
	3	178	662	46		
	4	93	395	27		
	5	87	254	25		
	6~	69	183	17		

Continued

Table 1 Continued

Characteristics		Current smoker	Never smoker	Former smoker	$\chi^2$	P value
Number of family members over 15 years old	1	172	562	59	13.02	0.223
	2	381	1253	149		
	3	165	607	44		
	4	120	355	38		
	5	33	82	7		
	6~	10	25	2		
Household income (¥)	<10 000	75	232	36	39.75	<0.001
	10 000–29 999	150	400	30		
	30 000–49 999	185	535	57		
	50 000–99 999	253	739	89		
	100 000–199 999	125	536	52		
	200 000–299 999	29	147	13		
	≥300 000	13	63	4		
	Don't know/refused	51	232	18		
Workplace	Indoors	516	1424	104	53.89	<0.001
	Outdoors	365	1460	195		
Smoking rules at home	Allowed	425	635	81	274.08	<0.001
	Not allowed, but exceptions	153	628	77		
	Never allowed	173	1226	95		
	No rules	130	395	46		
Approaches to hear about e-cigarettes	Yes	463	1162	142	43.41	<0.001
	No	418	1722	157		

the smoking rate of residents 15 years and older in high-income areas in China is 23.56%, which is lower than the smoking rate of 26.6% of the general population in China surveyed in the same year.<sup>4</sup> Studies have shown that the government in high-income areas of China has implemented a series of tobacco control policies, such as taking hospitals, transportation, shopping malls and other public places as key monitoring areas, forcing smoke-free measures and posting 'no smoking' warning signs, all of which have led to some success.<sup>19–23</sup>

The current characteristics of smokers in high-income areas in China are that they buy cigarettes for no more than ¥100 each time, they like to buy packaged cigarettes and they often smoke within 6–30 min after waking up in the morning; more than 40% of smokers have tried to quit smoking, and the main reason for quitting is worried about their health. Therefore, there are strong recommendations for smokers. First, through family education, our research shows that family regulations can reduce the likelihood of smoking; the second is to print health warning slogans on cigarette packs. Our research finds that people who quit smoking pay more attention to their own health, but the warnings on cigarette packs are often ignored. Therefore, we recommend that smokers pay attention to the harmful effects of tobacco use. The third is that doctors can strengthen the smoking-related education in patients. We found that only 54.57% of Chinese patients were asked about smoking history and their treatment by doctors,

73.60% of patients were advised to quit smoking and some patients failed to get a doctor's advice to quit smoking.

Sex, education level and tobacco health literacy are the main factors influencing smoking among residents in high-income areas of China. The multivariate logistic regression analysis of smoking in high-income areas of China showed that sex, education level, e-cigarette knowledge, family smoking regulations and tobacco health literacy are the main influencing factors of smoking among residents over 15 years old in high-income areas of China. Being a man is a risk factor for smoking, which is consistent with other related research results in China.<sup>24–26</sup> The smoking rate of men is 45.84%, that of women is 1.00% and the smoking probability of men is 129.92 times that of women (OR=129.92), which indicates that the smoking rate of women in high-income areas in China is not high, suggesting that the key population of tobacco control is still men.

Undergraduate/college education or above is a protective factor for smoking; a possible reason for this is that residents with higher education have more knowledge about health and are inclined to adopt to a healthy lifestyle.<sup>27</sup> The survey results show that consistent cigarette publicity is a risk factor for smoking, and some studies have shown that residents who have heard of e-cigarettes are more likely to try smoking out of curiosity. Regulations disallowing smoking, but with exceptions or no restrictions at home, are currently the protective factors of smoking, which may be because there are no explicit

**Table 2** Recent tobacco activities of current smokers

Questions	Valid case (%)
How soon after you wake up in the morning do you usually have your first smoke?	747
Within 5 min	152 (20.35)
6–30 min	242 (32.40)
31–60 min	124 (16.60)
More than 60 min	225 (30.12)
Refused to reply	4 (0.54)
The last time you bought cigarettes for yourself, did you buy loose cigarettes, packs, cartons or something else?	839
Cigarettes	8 (0.95)
Packs	458 (54.59)
Cartons	353 (42.07)
Never bought cigarettes/refused	20 (2.38)
How much money did you pay for the last time you purchased cigarettes? (¥)	809
<20	274 (33.87)
20–49	170 (21.01)
50–99	87 (10.75)
100–199	128 (15.82)
200–499	120 (14.83)
>500	30 (3.71)
The last time you purchased cigarettes for yourself, where did you buy them?	816
Kiosks/gas station/convenience store	186 (22.79)
Tobacco store/liquor store	171 (20.96)
Store/supermarket	430 (52.70)
Other	29 (3.55)
Do you currently use smokeless tobacco daily, less than daily or not at all?	881
Daily	17 (1.93)
Less than daily	6 (0.68)
Not at all	858 (97.39)

regulations about smoking at home, and family members will consider the feelings of other members, thus reducing the possibility of smoking. The higher the score of smoking health knowledge, the lower the possibility of smoking, probably because people with certain smoking health literacy can recognise the harm caused, and try to have some self-restraint to refuse smoking.

Given the need, this study provides strong policy recommendations. In China's high-income economic regions, men with high school education or below, who know about electronic cigarettes, are allowed to smoke at home. People with poor health literacy are those with a high smoking rate, and need professional smoking cessation advice to help them quit smoking and should

**Table 3** Cessation attempts and history

Question	Valid case (%)
Have you ever tried to stop smoking?	881
Yes	364 (41.32)
No	517 (58.68)
Which of the following best describes your thinking about quitting smoking?	881
Quit within the next month	29 (3.29)
Thinking within the next 12 months	62 (7.04)
Quit someday, but not in 12 months	143 (16.23)
Not interested in quitting	557 (63.22)
Don't know/refuse/missing	90 (10.22)
What was the most important reason for you to try to stop smoking last time?	364
Got illness	109 (29.95)
Worried about self-health	106 (29.12)
Heavy economic burden	25 (6.87)
Family's disapproval	61 (16.76)
Other	63 (17.31)
Thinking about the last time you tried to quit, how long did you stop smoking?	123
Months	70 (56.91)
Weeks	26 (21.14)
Days	24 (19.51)
Less than 1 day 24 hours	3 (2.44)
During any visit to a doctor or healthcare provider in the past 12 months, were you asked if you smoke tobacco?	361
Yes	197 (54.57)
No	164 (45.43)
During any visit to a doctor or healthcare provider in the past 12 months, were you advised to quit smoking tobacco?	197
Yes	145 (73.60)
No	52 (26.40)
Have the warnings on cigarette packs made you think about quitting?	818
Yes	197 (24.08)
No	597 (72.98)
No attention paid	24 (2.93)

be listed as key targets to provide professional smoking cessation help in China's high-income regions.

In addition, it is suggested that government departments in low and middle-income areas refer to the practices in high-income areas, such as setting up special smoking areas in some hospitals resulting in better conditions. At the same time, in order to achieve better tobacco control and become comparable with the global average level, the implementation of national smoke-free legislation should

**Table 4** Knowledge and attitude on smoking

Code	Statement about smoking	Yes	No	Uncertain
1	Smoking can cause serious illness.	3405 (83.78)	189 (4.65)	470 (11.56)
2	Smoking can cause stroke (blood clots in the brain that may causes paralysis).	1632 (40.16)	615 (15.13)	1817 (44.71)
3	Smoking can cause heart disease.	1964 (48.33)	528 (12.99)	1572 (38.68)
4	Smoking can cause lung cancer.	3232 (79.53)	142 (3.49)	670 (16.49)
5	Smoking can cause erectile dysfunction.	1065 (26.21)	425 (10.46)	2574 (63.34)
6	Secondhand smoke can cause serious illness among non-smokers.	2751 (67.69)	384 (9.45)	929 (22.86)
7	Secondhand smoke can cause heart disease in adults.	1538 (37.84)	698 (17.18)	1828 (44.98)
8	Secondhand smoke can cause lung illness in children.	2647 (65.13)	271 (6.67)	1146 (28.20)
9	Secondhand smoke can cause lung cancer in adults.	2569 (63.21)	302 (7.43)	1193 (29.36)
10	Do you think low-tar cigarettes are less harmful than regular cigarettes?	1270 (31.25)	819 (20.15)	1975 (48.60)
11	Do you think smoking should be allowed in hospital?	31 (0.76)	3927 (96.63)	106 (2.61)
12	Do you think smoking should be allowed in public transportation vehicles?	19 (0.47)	3929 (96.68)	116 (2.85)
13	Did you notice any health warnings on cigarette packages?	2275 (55.98)	921 (22.66)	868 (21.36)
14	Do you support printing health warning picture on cigarette packages?	2757 (67.84)	869 (21.38)	438 (10.78)
15	Do you support the increase in tax on cigarettes to increase their retail price?	1750 (43.06)	1233 (30.34)	1081 (26.60)
16	If there was an increase in the tax on cigarettes, do you think part of the money should be spent on tobacco control?	2854 (70.23)	426 (10.48)	784 (19.29)
17	If there was an increase in the tax on cigarettes, do you think part of the money should be spent on paying some of the costs of health insurance?	3296 (81.10)	245 (6.03)	523 (12.87)

be promoted as soon as possible to protect people from the harm of secondhand smoke. Second, increasing the tobacco tax, making tobacco more expensive, reducing its availability and making it less economically viable could reduce the number of smokers. Third, we should increase the awareness of the harm smoking causes to health, encourage the prohibition of smoking at home, increase investment in higher education, improve the residents' smoking health literacy level and achieve the goal of reducing people's smoking rate. Better control of the prevalence of smoking and providing corresponding help to quit smoking is required. Fourth, reduce the allure of tobacco use and prevent teenagers from smoking their first cigarette to control the number of new smokers.

### Limitations

This study has some limitations. First, China has a large population, the sample size of our study was relatively small and did not cover the entire population. Second,

there are many influencing factors of smoking, and we only measured some of them. Despite the limitations of the study, our research results are helpful for the classification and formulation of China's tobacco control policies. In the follow-up, we will continue to increase the number of relevant studies to improve our existing shortcomings.

### CONCLUSION

This study reveals the prevalence and main factors of smoking in high-income areas in China. The prevalence of smoking in high-income areas in China is lower than that in China as a whole; sex, education level and tobacco health literacy are the main factors influencing smoking among residents in high-income areas of China. Our research results can provide a good reference for China to formulate tobacco control policies in high-income areas.

**Table 5** Distribution of smoking knowledge scores

Scores	Current smoker	Never smoker	Former smoker	Total	X <sup>2</sup>	P value
1–4	271	585	62	918	49.68	<0.001
5–8	319	1065	117	1501		
9–12	291	1234	120	1645		

**Table 6** Factors associated with smoking

Independent variables	P value	OR	CI
Sex			
Women		1.00	
Men	<0.001	129.92	59.69 to 282.75
Education			
No formal schooling		1.00	
Less than primary school completed	0.556	0.68	0.19 to 2.45
Primary school completed	0.231	0.47	0.13 to 1.63
Less than secondary school completed	0.257	0.46	0.12 to 1.76
Secondary school completed	0.105	0.37	0.11 to 1.23
High school completed	0.059	0.30	0.09 to 1.05
College/university completed	0.002	0.14	0.04 to 0.51
Postgraduate degree completed	0.001	0.06	0.01 to 0.33
Know e-cigarettes			
No		1.00	
Yes	<0.001	2.01	1.48 to 2.73
Smoking rules at home			
Allowed		1.00	
Not allowed, but exceptions	<0.001	0.48	0.33 to 0.69
Never allowed	<0.001	0.24	0.17 to 0.35
No rules	0.002	0.52	0.34 to 0.78
Knowledge of smoking			
1–4		1.00	
5–8	0.001	0.49	0.33 to 0.73
9–12	0.003	0.53	0.35 to 0.81

**Correction notice** This article has been corrected since it was published. In the supplemental table S2, the labels male and female have been corrected.

**Contributors** Concept and design: LY and JS designed the study. PL and LL controlled the quality of the data and performed statistical analysis. LY, ZZ, ZW and LL managed and checked all the data. JS, ZZ and LY contributed to manuscript preparation, editing and review. All authors read, checked and approved the final manuscript. LY is responsible for the overall content as guarantor.

**Funding** This work was supported by the National Social Science Foundation of China (No 14BGL142).

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** At the time of the investigation of this research, ethics approval in China's disease prevention and control was obtained. We use its public data (all personal information has been deleted and no invasion of privacy occurred) for secondary analysis, so ethical review was no longer required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available in a public, open access repository. All the data we used have been publicly released on the GATS website: <http://ghdx.healthdata.org/record/china-global-adult-tobacco-survey-2018> (accessed on 5 January 2022).

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iD

Lei Yuan <http://orcid.org/0000-0001-9069-9481>

#### REFERENCES

- Münzel T, Hahad O, Kuntic M, *et al*. Effects of tobacco cigarettes, e-cigarettes, and waterpipe smoking on endothelial function and clinical outcomes. *Eur Heart J* 2020;41:4057–70.
- Murray CJL, Aravkin AY, Zheng P, *et al*. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *The Lancet* 2020;396:1223–49.
- Chen S, Kuhn M, Prettner K, *et al*. Noncommunicable diseases attributable to tobacco use in China: Macroeconomic burden and tobacco control policies. *Health Aff* 2019;38:1832–9.
- Chinese Center for Disease Control and Prevention. Data from: Chinese adult tobacco survey fact sheet, 2018, January 5, 2022. Available: [https://www.chinaccdc.cn/jkzt/sthd\\_3844/slh\\_4156/201908/t20190814\\_204616.html](https://www.chinaccdc.cn/jkzt/sthd_3844/slh_4156/201908/t20190814_204616.html)
- World Health Organization. Data from: WHO report on the global tobacco epidemic. 2019: *offer help to quit tobacco use 2022* <https://apps.who.int/iris/handle/10665/326043>
- Vijayaraghavan M, Pierce JP, White M, *et al*. Differential use of other tobacco products among current and former cigarette smokers by income level. *Addict Behav* 2014;39:1452–8.
- Samet JM. Tobacco smoking: the leading cause of preventable disease worldwide. *Thorac Surg Clin* 2013;23:103–12.
- Kostova D, Andes L, Erguder T, *et al*. Cigarette prices and smoking prevalence after a tobacco tax increase—Turkey, 2008 and 2012. *MMWR Morb Mortal Wkly Rep* 2014;63:457–61.
- Centers for Disease Control and Prevention (CDC). Response to increases in cigarette prices by race/ethnicity, income, and age groups—United States, 1976–1993. *MMWR Morb Mortal Wkly Rep* 1998;47:605–9.
- Farelly MC, Nonnemaker JM, Watson KA. The consequences of high cigarette excise taxes for low-income smokers. *PLoS One* 2012;7:e43838.
- Borren P, Sutton M. Are increases in cigarette taxation regressive? *Health Econ* 1992;1:245–53.
- Franks P, Jerant AF, Leigh JP, *et al*. Cigarette prices, smoking, and the poor: implications of recent trends. *Am J Public Health* 2007;97:1873–7.
- Mbulo L, Palipudi KM, Smith T, *et al*. Patterns and related factors of bidi smoking in India. *Tob Prev Cessat* 2020;6:28.
- Creamer MR, Wang TW, Babb S, *et al*. Tobacco Product Use and Cessation Indicators Among Adults - United States, 2018. *MMWR Morb Mortal Wkly Rep* 2019;68:1013–9.



- 15 Islami F, Stoklosa M, Drope J, *et al*. Global and regional patterns of tobacco smoking and tobacco control policies. *Eur Urol Focus* 2015;1:3–16.
- 16 World Bank. Data from: new country classifications by income level: 2018-2019. January 5, 2022. Available: <https://blogs.worldbank.org/opendata/new-country-classifications-income-level-2018-2019>
- 17 Chinese Center for Disease Control and Prevention. Data from: China global adult tobacco survey 2018, January 5, 2022. Available: <http://ghdx.healthdata.org/record/china-global-adult-tobacco-survey-2018>
- 18 Chen F, Hu P, Chang W, *et al*. A cross-sectional survey on cigarette smoking in the Chinese navy. *Mil Med* 2019;184:e211–7.
- 19 Qian X, Gu H, Wang L, *et al*. Changes in smoking prevalence after the enforcement of smoking control regulations in urban Shanghai, China: findings from two cross-sectional surveys. *Tob Induc Dis* 2018;16:27.
- 20 Wu Y, Wang Z, Zheng Y, *et al*. The impact of comprehensive tobacco control policies on cardiovascular diseases in Beijing, China. *Addiction* 2021;116:2175–84.
- 21 Zhao M. The public health implications of China's travel ban for smoking on trains. *Iran J Public Health* 2020;49:2009–10.
- 22 Au WW, Ma W, Zhu Q, Chen H, *et al*. Problems with cigarette smoking and attitudes towards the ban of smoking in Shantou, China. *Public Health* 2016;134:46–53.
- 23 Lin H, Chang C, Liu Z, *et al*. Subnational smoke-free laws in China. *Tob Induc Dis* 2019;17:78.
- 24 Yanjun X, Wenjun M, Haofeng X. Analysis on smoking pattern and relative risk factors in inhabitants aged 15 or elder in Guangdong Province. *Zhongguo Gong Gong Wei Sheng* 2005;21:899–901.
- 25 Hong P, Meng W, Xiaoyan H, *et al*. Investigation on smoking status of residents aged 15 years and over in Hangzhou. *Yu fang yi xue* 2020;32:253–7.
- 26 Haonan K, Xiaozhuo Z, Qin X. Prevalence of tobacco use and its influencing factors among residents aged 15 years and above in Chaoyang district. *Yu fang yi xue* 2021;33:94–6.
- 27 Yali D, Xiaofen L, Ying H. Investigation on smoking status of residents in Fangshan district of Beijing. *Zhongguo man xing bing yu fang yu kong zhi* 2019;27:528–32.

Table 1 Question of smoking

Code	Statement about smoking
1	Smoking can cause serious illness
2	Smoking can cause stroke (blood clots in the brain that many causes paralysis)
3	Smoking can cause heart disease
4	Smoking can cause lung cancer
5	Smoking can cause erectile dysfunction
6	Second-hand smoke can cause serious illness among non-smokers
7	Second-hand smoke can cause heart disease in adults
8	Second-hand smoke can cause lung illness in children
9	Second-hand smoke can cause lung cancer in adults
10	Do you think low tar cigarettes are less harmful than regular cigarettes?
11	Do you think smoking should be allowed in hospital
12	Do you think smoking should be allowed in public transportation vehicles

Table2 Survey area smoking rates

Province	Population (Ten thousand)			Smoking rates (%)		
	Female	Male	Total	Female	Male	Total
Beijing	952	978	1930	40.51	0.89	17.28
Tianjin	751	649	1400	48.65	4.88	25.64
Shanghai	1118	1068	2186	46.35	0.39	22.29
Jiangsu	3497	3446	6943	50.40	1.40	24.30
Zhejiang	2549	2402	4950	37.72	0.22	16.41
Fujian	1688	1593	3281	52.63	7.14	33.33
Guangdong	5069	4357	9426	40.93	0.51	47.60
Total	15625	14491	30116	44.52	1.62	30.75

Table 3 Question of smoking cessation

---

Code	Statement about smoking cessation
B16	During any visit to a doctor or health care provider in the past 12 months, were you asked if you smoke tobacco?
B17	During any visit to a doctor or health care provider in the past 12 months, were you advised to quit smoking tobacco?
D02A	Thinking about the last time you tried to quit, how long did you stop smoking?

---