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Impact of smoking on the income level of Chinese urban residents: an analysis based on panel data

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Abstract

Objectives

This study attempts to analyze the impact of smoking on the income level of Chinese urban residents, to obtain an accurate understanding of the economic losses resulting from smoking and to provide a reference for creating informed regulations on cigarette smoking.

Setting

The data in this study were derived from the China Family Panel Studies (CFPS). CFPS cover 25 provinces/municipalities/autonomous regions in the country .

Participants

Two waves of panel data in 2014 and 2016 from the China Family Panel Study (CFPS) were used. A total of 8025 urban adults were identified.

Primary and secondary outcome measures

Respondents were divided into groups of non-smokers, current smokers, and former smokers, The dependent variable in this study was the income of urban residents.

Results

The percentage of current smokers decreased from 27.39% (2014) to 26.24% (2016), while the percentage of former smokers rose from 9.78% to 11.78%. The results from the Hausman-Taylor model showed that smoking had a significant negative impact on the income of urban residents and that the income of current smokers and former

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smokers decreased by 29.70% and 35.60%, respectively. According to calculations based on the two-year average disposable income of urban residents, current and former smokers in China are expected to reduce the disposable income of urban residents by $436.78 billion, which accounts for 4.09% of the two-year average GDP. After eliminating the impact of smoking on income, the incidence of poverty among urban residents decreased from 15.33% to 14.11%.

Conclusions

Smoking can significantly reduce the income of Chinese urban residents, resulting in immense negative impacts on Chinese society. Therefore, the government should raise the tax rate on tobacco, include smoking cessation treatment in medical insurance coverage, promote publicity campaigns on the awareness of tobacco hazards, and encourage smokers to quit smoking early.

Article Summary

- This study supplements the empirical research conclusions on the relationship between smoking and resident income in China.
- Two-wave balance panel data can improve the effectiveness of model estimation and the estimation accuracy.
- The Hausman-Taylor model can also overcome the endogeneity problems with the instrumental variables automatically generated from internal information in the model.
- Type of employment may impact residents' income, but it could not be included in

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the model due to the massive amount of missing data in the CFPS database.

Introduction

China is the world's largest cigarette producer, manufacturer and consumer. According to the "China adult tobacco control report 2015", China has a smoking population of approximately 316 million people.[1] Diseases caused by smoking, such as cardiovascular diseases, cancer, and chronic respiratory diseases, have become China's major health threats.[2-5] From 1990 to 2010, the number of deaths caused by smoking increased from 700,000 to 1.4 million.[6] Smoking-attributable deaths per year in China are predicted to reach 3 million by 2050 if the problem remains unchecked.[7]

It is well known that smoking negatively impacts people's health. Recently, an increasing number of scholars have been paying attention to the impact of smoking on personal income level. Most research shows that smoking negatively affects income. Bockerman et al. noted the long-term negative impact of smoking on the income of Finnish males. [8] Auld concluded that Canadian smokers' income was 8% lower than the nonsmokers' income, and the smoking penalty rose to 24% after correcting for endogeneity. [9] Dutch smokers are paid approximately 10% less than non-smokers according to Van Ours' research results. [10] Lokshin et al. used data from the 2005 Albanian Living Standards Surveillance Survey and discovered that smokers earn 20% less than non-smokers.[11] In addition, a few studies have also shown less significant relationships between smoking and individual income. Lye et al. used 1995 Australian National Health Survey data to suggest that cigarette smoking did not significantly impact personal income. [12]

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Previous studies have shown that three major reasons cause smoking to reduce income. First, smoking reduces the productivity of smokers. Kristein believes that smokers have more absent time and relatively lower productivity caused by smoking breaks or sick leave due to poor health.[13] Second, smokers have a relatively higher time preference, which means that they prefer current consumption to investment for the future. This preference may result in lower human capital investment in themselves, which in turn leads to lower income.[14] Third, smokers are personally less attractive than non-smokers. Smoking affects an individual's personal appearance and smell and, thus, reduces his or her personal attractiveness.[15]

There is a limited amount of related studies in China. Yin et al. concluded that smoking does not significantly affect resident income using data from the 1991-2006 China Health and Nutrition Survey. [16] The methodology adopted in this research involved a pooled regression model; however, this approach has limitations. The usage of panel data as the pooled data ignores the individual effects of research objects, which yields a research result that may not be robust. This study explores the possible impact of smoking on Chinese residents' income, with the aim to contribute to the methodologies used in previous Chinese studies, to accurately estimate the economic losses caused by smoking and to provide useful evidence for tobacco intervention policy making decisions.

Data and Model

Data Resources

The data in this study were derived from the China Family Panel Studies (CFPS) operated by the China Social Science Research Center (ISSS) of Beijing University.[17] CFPS is a national, large-scale, multidisciplinary social tracking survey project conducted every two years starting from 2010. CFPS adopted an implicit stratification strategy involving a multiphase and multilevel probability sampling method proportional to size, covering 25 provinces/municipalities/autonomous regions in the country (unsampled provinces/municipalities/autonomous regions include Hong Kong, Macau, Taiwan, Xinjiang, Tibet, Qinghai, Inner Mongolia, Ningxia and Hainan). Based on the regional distribution of sampling and the sampling method, this database is well representative and rigorous.

Face-to-face computer-assisted personal interviews involving demographic background, smoking habits, health status and personal income were conducted to ensure the objectivity and logicality of the data. This study used four waves of data that were publicly released by the CFPS. Since the CFPS questionnaire included rural residents' agricultural income in the household income data and it is difficult to accurately define the personal income of rural residents, the research subjects were limited to urban residents.

Study sample

CFPS surveyed 10,874 and 9,942 urban individuals in 2014 and 2016, respectively, and 73.80% of individuals were successfully followed in the four waves. We eventually included 4,428 households and 8,025 respondents and constructed balanced panel data.

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Measures

Smoking variables—Respondents were divided into groups of non-smokers, current smokers, and former smokers. The CFPS questionnaire asked, "Have you smoked in the last month?" When the respondent answered "yes", the individual was categorized as a "current smoker"; if the respondent answered “no”, he or she was then asked, "Have you ever smoked?" If the respondent answered "yes", the individual was considered to be a "former smoker"; if the answers to both questions were "no", the respondent was considered a nonsmoker.

Control variables—Demographic characteristics included gender (female or male), age, education (primary school and below, middle school and high school, or junior college and above), marital status (in a marriage: married/cohabiting or not in a marriage: single or separated/divorced/widowed), self-rated health status (poor, average, or healthy), chronic disease status (yes or no), health insurance status (yes or no), alcohol intake (yes or no), employment status (yes or no), and location (western regions: seven provincial administrative regions including Sichuan, Chongqing, Guizhou, and Yunnan; central regions: eight provincial administrative regions including Shanxi, Jilin, Heilongjiang, and Anhui; and eastern regions: 10 provincial-level administrative regions including Beijing, Tianjin, Hebei, and Liaoning),[18] and the survey year (2014 or 2016).

Dependent variable—The dependent variable in this study was the income of urban residents. The income variable was the total annual income of the respondents,

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including annual wages, overtime wages and bonuses, year-end bonuses, physical conversions received, income from a second occupation, retirement pensions, and net income from personal businesses. To eliminate the impact of price factors on income in different years, the consumer price index was used to correct the nominal value of income in 2016, which was converted to personal income measured at constant prices in 2014.

Patient and Public Involvement

No patient involved.

Statistical analysis

In the study of the effects of smoking on income, data endogeneity is unavoidable. There are two causes for this endogeneity. One cause may be omitted variables that have an impact on outcome. For example, people with less self-control are more likely to develop a smoking habit. Self-control is an omitted variable that is rarely observed in research. Another possibility is that income level might affect smoking behaviors. Smoking is addictive, and smoking behaviors are difficult to change. Analyzing them with the select panel data fixed effect model will result in a loss of samples with unchanged smoking status and, thus, fitting model parameters that deviate from reality. To ensure the robustness of the analysis results, this study used the Hausman-Taylor model. The basic principle of the Hausman-Taylor model is to solve the endogeneity problems with the instrumental variables automatically generated from internal information in the model. In addition, the model can include variables that do not

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change over time and, thus, reduce sample loss.[19]

The basic econometric model of smoking impact on income was structured on Mincer's income equation by introducing smoking status variables into independent variables,[20] which were finally modified to obtain the Hausman-Taylor model.

$$\mathrm{Ln}(\mathrm{Income}_{it}) = \beta_0 + \beta_1 \mathrm{Smoking}_{it} + \beta_2 X_{it} + \eta Z_i + a_i + u_{it} \quad (1)$$

In the formula, $\mathrm{Ln}(\mathrm{Income}_{it})$ represents the logarithm of the annual income of individual i in t years; $\mathrm{smoking}_{it}$ is a dummy variable of the smoking status of the respondents; X_{it} is a control variable that changes over time, which includes age, education level, marital status, self-rated health status, chronic disease status, medical insurance status, alcohol consumption status, employment status, location, and survey year; Z_i is a control variable that remains unchanged over time, which includes gender; α_i indicates the differences between individuals and remains unchanged over time; and u_{it} is the error term. A semilogarithmic equation means that a change in the independent variable causes a percentage change in the dependent variable when other variables remain constant.

A two-tailed p value of <0.05 was considered statistically significant. All data in this study were analyzed with STATA (version 14.0, MP).

Results

Table 1 reports the sociodemographic characteristics of urban residents in 2014 and 2016. The gender variables were consistent throughout the years: 4,245 male samples

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accounted for 52.90%, while 3,779 female samples accounted for 47.10%. The percentage of current smokers dropped from 27.39% in 2014 to 26.24% at the end of 2016, and the percentage of former smokers increased from 9.78% to 11.78%. The annual income of the urban residents showed an overall upward trend, increasing from 2761.93 US dollars in 2014 to 4807.02 US dollars in 2016. The education level of the urban residents was generally not high, and more than half of the subjects were graduates from middle school or high school. The prevalence of chronic disease in both 2014 and 2016 was approximately 20%. More than 60% of the respondents rated their health status as healthy.

Table 1 Characteristics of urban resident in 2014 and 2016, China

variables		2014 (N=8025)	2016 (N=8025)
Smoking status N(%)	Non smokers	5042(62.83)	4974(61.98)
	Current smokers	2198(27.39)	2106(26.24)
	Former smokers	785(9.78)	945(11.78)
Annual income(US dollars) (Mean±SD)		2761.93±4927.22	4807.02±9163.16
Gender n(%)	Male	4245(52.90)	4245(52.90)
	Female	3779(47.10)	3779(47.10)
Age (Mean±SD)		50.08±14.34	52.14±14.31
Marital status n(%)	Married	6974(86.92)	6977(86.94)
	not in marriage	1050(13.08)	1048(13.06)
Education level	Primary school and below	2866(35.71)	2866(35.71)

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n(%)	Middle school and High school	4120（51.34）	4110（51.21）
	junior college and above	1039（12.95）	1049（13.07）
Self-rated health status	poor	1143(14.24)	1193(14.87)
	Average	1351(16.83)	1788(22.28)
n(%)	Healthy	5531(68.92)	5044(62.85)
Having chronic disease or not	Yes	1629(20.30)	1637(20.40)
n(%)	No	6396(79.70)	6388(79.60)
Health Insurance status	Yes	7304(91.01)	7359(91.7)
n(%)	No	721(8.98)	666(8.3)
Work status	Yes	5254(65.47)	5096(63.50)
n(%)	No	2771(34.53)	2929(36.50)
Alcohol intake	Yes	1305(16.26)	1271(15.84)
n(%)	No	6720(83.74)	6754(84.16)
Western regions	Western regions	1278(15.93)	1269(15.81)
n(%)	Central regions	2452(30.55)	2449(30.52)
	Eastern regions	4295(53.52)	4307(53.67)

Exchange rate of the Chinese Yuan against US$ were6.14 and 6.64 in 2014 and 2016 based on China Statistical Yearbook, 2017. [21]

Figure 1 shows the distribution of income levels for the different smoking status categories in 2014 and 2016. All urban residents were divided into 5 groups based on their annual income levels. The levels ranged from 1 to 5 and represented the population groups from the lowest 20% income group to the top 20% income group, respectively. Our studies have shown that the percentage of high-income non-smokers rose from 17.22% in 2014 to 19.12% in 2016, while the percentage of low-income non-smokers decreased from 22.05% to 20.14%. The percentage of high-income current smokers

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decreased from 26.30% in 2014 to 22.46% in 2016, while the percentage of low-income current smokers rose from 14.56% to 19.66%. The percentage of high-income former smokers decreased from 20.25% in 2014 to 19.15% in 2016, and the percentage of low-income former smokers decreased from 22.04% to 20.00%.

Figure1 Income distribution of urban resident in different smoking status in 2014 and 2016 , China

Table 2 presents the effects of smoking on the income of urban residents. Model 1 is an analysis of the income impact among all respondents. Models 2, 3, and 4 analyze the effects of smoking on the income level of different age groups, namely, young people (<40 years), middle-aged people (40 to 59 years old) and elderly people (≥60 years old).[22] As is shown in model 1, smoking has a significant negative impact on income ($P < 0.05$). Compared to the annual income of non-smokers, the annual income of current smokers decreased by 29.7%, and the annual income of former smokers decreased by 35.6%. With improvements in education, the annual income of urban residents also increased. The income of residents with good self-rated health was significantly higher than that of urban residents with poor self-rated health. Smoking did not significantly affect the annual income of the young and elderly urban residents (see models 2 and 4), but it significantly reduced the income of middle-aged urban residents. In comparison to the annual income of non-smokers, the annual income of current smokers and former smokers decreased by 33.1% and 39.7%, respectively (see model 3).

Table 2 Analysis of the effect of smoking on income among Chinese urban residents

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Variables	Model1 (Total population)	Model 2 (Young people)	Model 3 (Middle-aged people)	Model4 (Elderly people)
Smoking status (reference group: Non smokers)				
Current smokers	-0.297**	0.0645	-0.331*	0.0560
	(-2.08)	(0.41)	(-1.66)	(0.16)
Fomer smokers	-0.356**	0.0311	-0.397*	-0.180
	(-2.33)	(0.18)	(-1.86)	(-0.50)
alcohol intake(reference group: no)	0.00865	0.0244	0.132***	-0.173**
	(0.23)	(0.47)	(3.25)	(-2.23)
Gender (reference group: female)	0.492***	0.261**	0.491***	0.247
	(3.92)	(2.28)	(3.33)	(0.98)
Age	-0.0257***	0.00880*	-0.0190***	-0.00272
	(-8.77)	(1.75)	(-6.42)	(-0.30)
Marital status (reference group: not in marriage)	-0.265***	0.00385	0.139**	-0.0831
	(-4.49)	(0.07)	(2.39)	(-0.75)
Education (reference group:primary school and below)				
Middle school and high school	0.508***	0.450***	0.265***	0.692***
	(5.80)	(6.09)	(7.49)	(5.78)
Junior college and above	0.953***	0.965***	1.064***	1.273***
	(7.36)	(11.61)	(17.33)	(5.10)

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Self rated health(reference group:poor)				
Average	0.0516	0.0380	0.0809*	-0.00396
	(1.34)	(0.48)	(1.85)	(-0.06)
Healthy	0.0808**	-0.00742	0.158***	0.149**
	(2.17)	(-0.10)	(3.87)	(2.42)
Having chronic disease or not	0.0801***	0.0594	0.0296	0.127***
(reference group: no)	(2.86)	(1.12)	(0.88)	(2.79)
Insurance status	-0.0949***	0.0952***	-0.0271	-0.0848
(reference group: no)	(-3.19)	(2.66)	(-0.77)	(-1.36)
Work status	0.171***	0.411***	0.216***	0.0937
(reference group: unemployed)	(5.29)	(9.37)	(6.50)	(1.45)
Location (reference group: western regions)				
Central regions	-0.00805	0.100	0.0958**	-0.00224
	(-0.07)	(1.33)	(2.00)	(-0.01)
Eastern region	0.273***	0.391***	0.395***	0.341**
	(2.70)	(5.53)	(8.78)	(2.28)
Year (reference group: 2014)				
2016	1.090***	0.323***	0.575***	2.461***
	(73.97)	(14.59)	(28.94)	(75.11)
constant	9.581***	8.082***	9.214***	6.852***
	(46.18)	(42.48)	(52.55)	(10.40)

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N	16050	3936	7518	4596

t statistics in parentheses

** p < 0.1, ** p < 0.05, *** p < 0.01*

As shown in Table 3, the average incidence of poverty among Chinese urban residents in 2014 and 2016 was 15.33%, among which the incidences of poverty among former smokers, current smokers, and non-smokers were 16.01%, 12.59%, and 16.38%, respectively. The lowest income group had the highest poverty rate among all income groups. After eliminating the impact of smoking on income, which means raising the annual income of current smokers and former smokers by 29.70% and 35.60%, respectively, the incidence of poverty among urban residents was reduced to 14.11%, and the incidence of poverty among former smokers and current smokers was reduced to 11.73% and 9.76%, respectively.

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Table 3 The incidence of poverty among Chinese urban residents at different smoking status and income levels

category	Income level	Non smokers	Current smokers	Former smokers	total
Impact of smoking on income retained	Q1 (lowest 20% income)	61.35	54.90	58.84	59.60
	Q2	16.54	18.24	17.39	17.04
	Q3	0	0	0	0
	Q4	0	0	0	0
	Q5(top 20% income)	0	0	0	0
	Sub-total	16.38	12.59	16.01	15.33
Impact of	Q1 (lowest 20% income)	61.35	51.50	56.08	58.50
	Q2	16.54	5.51	0	12.02

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smoking on income eliminated	Q3	0	0	0	0
	Q4	0	0	0	0
	Q5(top 20% income)	0	0	0	0
	小计 Sub-total	16.38	9.76	11.73	14.11

Note: The poverty line criterion used was the 2010 poverty line standard of 2300 yuan per year . The nominal value was corrected with the consumer price index and transformed based on the poverty line measured by the constant price of 2014.

Discussion

This study revealed that smoking has a significant negative impact on the income of urban residents in China. The current annual income of current smokers was 29.70% less than that of non-smokers, while the income of former smokers was 35.60% less than that of non-smokers. Based on the average disposable income of urban residents in two consecutive years, smoking reduced the income of Chinese urban residents by 436.78 billion US dollars, which accounted for 4.09% of the two-year average GDP. After eliminating the impact of smoking on income, the incidence of poverty among urban residents was reduced by more than one percent, which means a population of approximately 9.5 million people were no longer in poverty.

This study revealed a higher impact of smoking on income than in previous studies. [9-11] Possible reasons are as follows. First, Chinese smokers consume an average of 15.2 cigarettes per day, [1] which reaches a heavy smoking level. [23] The greater the amount of smoking, the more serious health impacts there will be, which will result in a greater impact on personal income.[24-26] Second, in previous studies, smoking status was categorized into two groups, namely, smoking and nonsmoking, which mistakenly

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categorized former smokers as non-smokers and thus underestimated the impact of smoking on income.

Smoking had different impacts on the personal income of people in different age groups. Smoking significantly reduced the income of middle-aged urban residents but did not significantly affect the income of young and elderly residents. The possible reasons are as follows. First, the harms of smoking have a cumulative and delayed effect, and the impacts of smoking on health are not yet evident in one's youth.[27] After smokers become middle aged, smoking gradually shows its negative impact on health.[28] Second, the current legal retirement age for Chinese workers is 60 for men and 50-55 for women.[29] Most people in age groups over 60 have retired with relatively stable retirement pensions. Therefore, there is little relation between their income and health status. Moreover, the relationship between health status and work hours as well as work ability also is minimally related to income.

From a policy perspective, reduction of smoking prevalence is not only a matter of public health concern but also closely related to the reduction of poverty. Smoking may increase the incidence of poverty in low-income groups, thereby further increasing the gap between the rich and the poor.[30] Reducing the smoking prevalence means decreasing the reduction of income caused by smoking. As the most populated middle-income country in the world, China has always aimed to reduce and eradicate poverty as a long-term task in the process of economic development.[31] To control the harm of tobacco, it is first recommended to make the most of the battle against poverty by

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integrating tobacco control strategies with national poverty alleviation policies. This effort will help overcome various economic and political obstacles in the implementation of existing tobacco control measures and facilitate the Chinese government's efforts to build a comprehensive, healthy society. Second, it is recommended to gradually increase the tax rate on tobacco and thereby increase cigarette retail prices to curb the tobacco epidemic. Raising tobacco taxes is the most cost-effective way to reduce tobacco use.[32] In addition, low-income groups are more sensitive to price changes; therefore, it is easier to reduce the demand for cigarettes among these groups.[33] Consequently, the low-income groups will receive most of the health and economic benefits of tax increases,[34] which is conducive to reducing the financial risks of low-income groups and the incidence of poverty. Third, it is recommended to cover smoking cessation treatment in medical insurance to alleviate the financial burden on smokers. Research has shown that patients with medical insurance are more willing to quit smoking than patients without medical insurance and that expanding health insurance coverage can improve the smoking cessation rate.[35] Fourth, it is recommended to promote publicity campaigns about tobacco harm and to encourage smokers to quit smoking as early as possible. The low awareness of Chinese residents about the harm of tobacco is to some degree related to the tobacco industry's use of "low tar" marketing strategies; therefore, it is recommended to stop implementing this deceptive tobacco marketing strategy.[36] Furthermore, the effect of warnings on tobacco packaging are not adequate. Studies have shown that the combination of text and pictures is more alarming than just a text warning.[37] It is

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therefore recommended to promote the use of warning pictures instead of the traditional text warnings on cigarette packages.

The major contributions of this paper lie in the following three aspects. First, we have supplemented the empirical research conclusions on the relationship between smoking and resident income in China. Moreover, two-wave balance panel data can provide more data points, increase the degree of data freedom, reduce the degree of colinearity between explanatory variables, and thus improve the effectiveness of model estimation. It can also control individual heterogeneity, which helps improve the estimation accuracy.[38] Finally, the Hausman-Taylor model successfully addresses the problems of inconsistencies in the random effects model and the ineffectiveness of the fixed effects model by avoiding the disadvantages of the pooled regression model, which fails to consider the influence of individual differences. In addition, the Hausman-Taylor model can also overcome the endogeneity problems with the instrumental variables automatically generated from internal information in the model. [19]

Nevertheless, this study has some limitations. First, type of employment may have an impact on residents' income but could not be included in the model due to the massive amounts of missing employment data in the CFPS database. Second, the study was limited to urban residents without consideration of the impact of smoking on the income of other populations.

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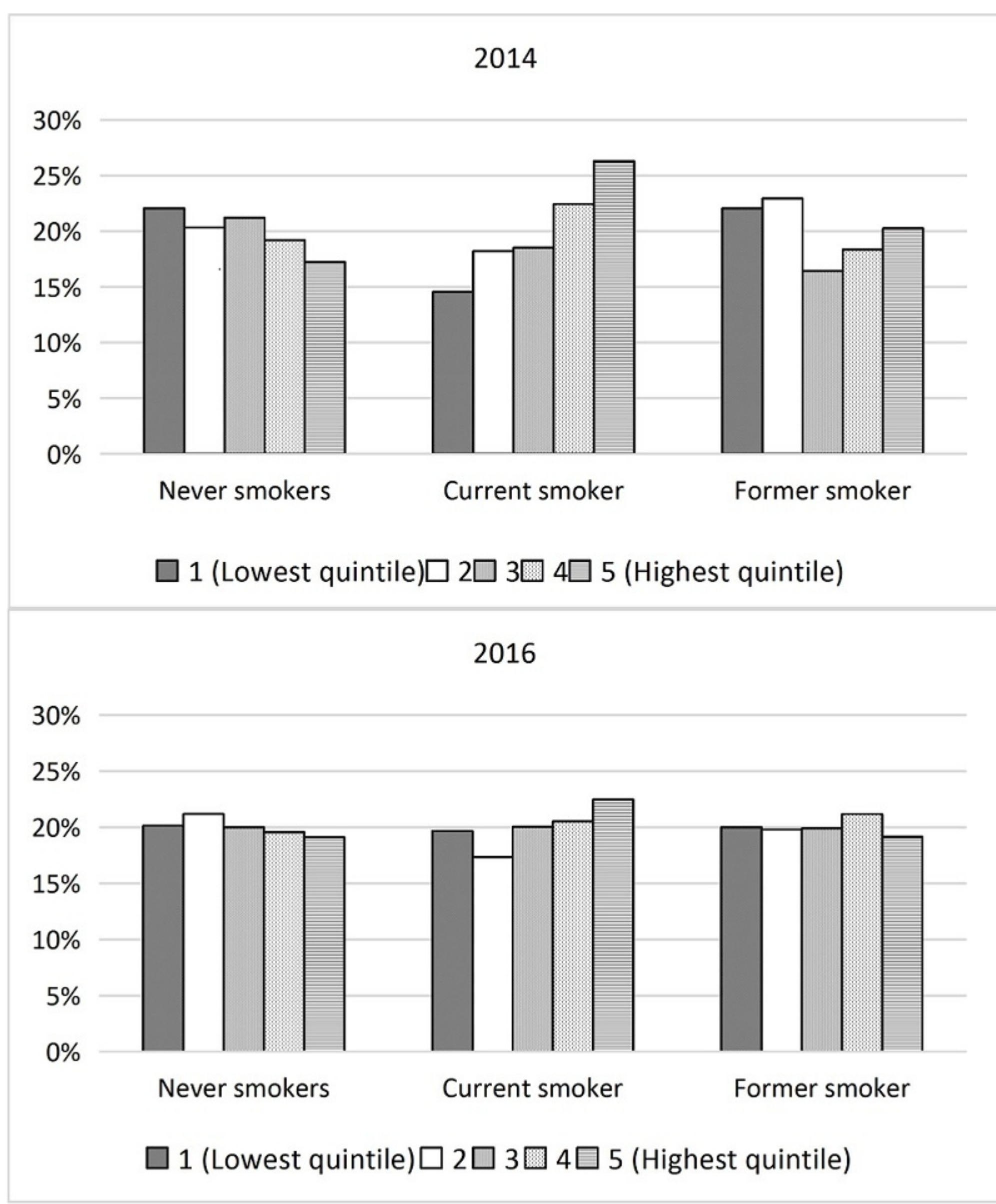

Figure1 Income distribution of urban resident in different smoking status in 2014 and 2016 , China

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Dear Editors:

Based on a national large-scale longitudinal database in China, this study used econometric models to estimate he impact of smoking on the income level of Chinese urban smokers. According to EQUATOR, no relevant checklist is available for our study type.

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Impact of smoking on the income level of Chinese urban residents: a 2-wave follow-up of the China Family Panel Study

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Primary Subject Heading:	Smoking and tobacco
Secondary Subject Heading:	Health economics
Keywords:	HEALTH ECONOMICS, Health economics < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH

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Impact of smoking on the income level of Chinese urban residents: a 2-wave follow-up of the China Family Panel Study

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Abstract

Objectives

This study attempts to analyze the impact of smoking on the income level of Chinese urban residents, to obtain an accurate understanding of the economic losses resulting from smoking and to provide a reference for creating informed regulations on cigarette smoking.

Design

A population-based cohort study.

Method

Two waves of panel data in 2014 and 2016 from the China Family Panel Study (CFPS) were used. A total of 8025 urban adults were identified. The Hausman-Taylor model was used to analyze the theoretical relationship between smoking and income.

Results

The percentage of current smokers decreased from 27.39% (2014) to 26.24% (2016), while the percentage of former smokers rose from 9.78% to 11.78%. The results from the Hausman-Taylor model showed that smoking had a significant negative impact on the income of urban residents and that the income of current smokers and former smokers decreased by 37.70% and 44.00%, respectively. After eliminating the impact of smoking on income, the poverty rate among urban residents decreased from 15.33% to 13.63%.

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Conclusions

Smoking can significantly reduce the income of Chinese urban residents, resulting in immense negative impacts on Chinese society. Therefore, the government should raise the tax rate on tobacco, include smoking cessation treatment in medical insurance coverage, promote publicity campaigns on the awareness of tobacco hazards, and encourage smokers to quit smoking early.

Article Summary

- This study supplements the empirical research conclusions on the relationship between smoking and resident income in China.
- Two-wave balance panel data can improve the effectiveness of model estimation and the estimation accuracy.
- The Hausman-Taylor model can also overcome the endogeneity problems with the instrumental variables automatically generated from internal information in the model.
- The study was limited to urban residents without consideration of the impact of smoking on the income of other populations.

Introduction

China is the world's largest cigarette producer, manufacturer and consumer. As shown in the 2018 Global Adult Tobacco Survey (GATS) data, the current smoking prevalence of Chinese people aged 15 and above is 26.6%, and the population of smokers has reached 308 million.[1] Diseases caused by smoking, such as cardiovascular diseases,

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cancer, and chronic respiratory diseases, have become China's major health threats.[2-5] From 1990 to 2010, the number of deaths caused by smoking increased from 700,000 to 1.4 million.[6] Smoking-attributable deaths per year in China are predicted to reach 3 million by 2050 if the problem remains unchecked.[7]

It is well known that smoking negatively impacts people's health. Recently, an increasing number of scholars have been paying attention to the impact of smoking on personal income level.[8-12] Most research shows that smoking negatively affects income. Bockerman et al. noted the long-term negative impact of smoking on the income of Finnish males. [8] Auld concluded that Canadian smokers' income was 8% lower than the nonsmokers' income, and the smoking penalty rose to 24% after correcting for endogeneity. [9] Dutch smokers are paid approximately 10% less than non-smokers according to Van Ours' research results. [10] Lokshin et al. used data from the 2005 Albanian Living Standards Surveillance Survey and discovered that smokers earn 20% less than non-smokers.[11] In addition, a few studies have also shown less significant relationships between smoking and individual income. Lye et al. used 1995 Australian National Health Survey data to suggest that cigarette smoking did not significantly impact personal income. [12]

Previous studies have shown that three major reasons cause smoking to reduce income. First, smoking reduces the productivity of smokers. Kristein believes that smokers have more absent time and relatively lower productivity caused by smoking breaks or sick leave due to poor health.[13] Second, smokers have a relatively higher time preference,

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which means that they prefer current consumption to investment for the future. This preference may result in lower human capital investment in themselves, which in turn leads to lower income.[14] Third, smokers are personally less attractive than non-smokers. Smoking affects an individual's personal appearance and smell and, thus, reduces his or her personal attractiveness.[15]

There is a limited amount of related studies in China. Yin et al. concluded that smoking does not significantly affect resident income using data from the 1991-2006 China Health and Nutrition Survey. [16] The methodology adopted in this research involved a pooled regression model; however, this approach has limitations. The usage of panel data as the pooled data ignores the individual effects of research objects, which yields a research result that may not be robust. This study explores the possible impact of smoking on Chinese residents' income, with the aim to contribute to the methodologies used in previous Chinese studies, to accurately estimate the economic losses caused by smoking and to provide useful evidence for tobacco intervention policy making decisions.

Data and Model

Data Resources

The data in this study were derived from the China Family Panel Studies (CFPS) operated by the China Social Science Research Center (ISSS) of Beijing University.[17] CFPS is a national, large-scale, multidisciplinary social tracking survey project conducted every two years starting from 2010. CFPS adopted an implicit stratification

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strategy involving a multiphase and multilevel probability sampling method proportional to size, covering 25 provinces/municipalities/autonomous regions in the country (unsampled provinces/municipalities/autonomous regions include Hong Kong, Macau, Taiwan, Xinjiang, Tibet, Qinghai, Inner Mongolia, Ningxia and Hainan). Based on the regional distribution of sampling and the sampling method, this database is well representative and rigorous.

Face-to-face computer-assisted personal interviews involving demographic background, smoking habits, health status and personal income were conducted to ensure the objectivity and logicality of the data. This study used two waves of data that were publicly released by the CFPS. Since the CFPS questionnaire included rural residents' agricultural income in the household income data and it is difficult to accurately define the personal income of rural residents, the research subjects were limited to urban residents.

Ethics committee

Research ethical or governance approval is exempt for this study as no new data are being collected.

Patient and Public Involvement

All data in this study were derived from the CFPS database, no patient and the public were involved in the design or planning of this study.

Study sample

CFPS surveyed 10,874 and 9,942 urban individuals in 2014 and 2016, respectively, and

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73.80% of individuals were successfully followed in the two waves. We eventually included 4,428 households and 8,025 respondents and constructed balanced panel data.

Measures

Smoking variables—Respondents were divided into groups of non-smokers, current smokers, and former smokers. The CFPS questionnaire asked, "Have you smoked in the last month?" When the respondent answered "yes", the individual was categorized as a "current smoker"; if the respondent answered “no”, he or she was then asked, "Have you ever smoked?" If the respondent answered "yes", the individual was considered to be a "former smoker"; if the answers to both questions were "no", the respondent was considered a nonsmoker.

Control variables—Demographic characteristics included gender (female or male), age(<35 years old,35-~years old,⩾60 years old), education (primary school and below, middle school and high school, or junior college and above), marital status (in a marriage: married/cohabiting or not in a marriage: single or separated/divorced/widowed), self-rated health status (poor, average, or healthy), chronic disease status (yes or no), health insurance status (yes or no), alcohol intake (yes or no), doing physical exercise or not (yes or no), type of employment (unemployed, manager, professional and technical personnel, clerks and related personnel, service personnel, workers in agricultural, forestry, animal husbandry, fishing and water conservancy sectors, production workers and transportation equipment operators and related personnel, Others), GDP per capita and the survey year

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7 **Dependent variable**—The dependent variable in this study was the income of urban residents. The income variable was the total annual income of the respondents, including annual wages, overtime wages and bonuses, year-end bonuses, physical conversions received, income from a second occupation, retirement pensions, and net income from personal businesses. To eliminate the impact of price factors on income in different years, the consumer price index was used to correct the nominal value of income in 2016, which was converted to personal income measured at constant prices in 2014.

Poverty rate—The poverty line criterion used was the 2010 poverty line standard of 2300 yuan per year . The nominal value was corrected with the consumer price index and transformed based on the poverty line measured by the constant price of 2014. Measuring the extent of poverty, poverty rate represents the percentage of people below the poverty line in the total population.

Statistical analysis

In the study of the effects of smoking on income, data endogeneity is unavoidable. There are two causes for this endogeneity. One cause may be omitted variables that have an impact on outcome. For example, people with less self-control are more likely to develop a smoking habit. Self-control is an omitted variable that is rarely observed in research. Another possibility is that income level might affect smoking behaviors.[16] Smoking is addictive, and smoking behaviors are difficult to change. Analyzing them

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with the select panel data fixed effect model will result in a loss of samples with unchanged smoking status and, thus, fitting model parameters that deviate from reality.[18] To ensure the robustness of the analysis results, this study used the Hausman-Taylor model. The basic principle of the Hausman-Taylor model is to solve the endogeneity problems with the instrumental variables automatically generated from internal information in the model. In addition, the model can include variables that do not change over time and, thus, reduce sample loss.[19]

The basic econometric model of smoking impact on income was structured on Mincer's income equation by introducing smoking status variables into independent variables,[20] which were finally modified to obtain the Hausman-Taylor model.

$$\mathrm{Ln}(\mathrm{Income}_{it}) = \beta_0 + \beta_1 \mathrm{Smoking}_{it} + \beta_2 X_{it} + \eta Z_i + a_i + u_{it} \quad (1)$$

In the formula, $\mathrm{Ln}(\mathrm{Income}_{it})$ represents the logarithm of the annual income of individual i in t years; $\mathrm{smoking}_{it}$ is a dummy variable of the smoking status of the respondents; X_{it} is a control variable that changes over time, which includes age, education level, marital status, self-rated health status, chronic disease status, medical insurance status, alcohol consumption status, employment status, location, and survey year; Z_i is a control variable that remains unchanged over time, which includes gender; α_i indicates the differences between individuals and remains unchanged over time; and u_{it} is the error term. A semilogarithmic equation means that a change in the independent variable causes a percentage change in the dependent variable when other variables remain constant.

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This study describes the sociodemographic characteristics (gender, age, education levels, marital status, etc.), health behaviors (including smoking status, alcohol intake, and doing physical exercise or not), and health status (Self-rated health status and Having chronic disease or not), Health Insurance status, type of employment, per capita GDP and income of Chinese urban residents in years 2014 and 2016 (see Table 1); Moreover, this study describes the smoking status among different characteristics groups (gender, age) of Chinese urban residents in 2014 and 2016 (see Table 2); In addition, it analyzes income distribution of urban resident in different smoking status (see Figure 1); It also analyzes the effect of smoking on income among Chinese urban residents; (see Table 3); Finally, it describes poverty rate in different smoking status (see Table 4).

A two-tailed p value of <0.05 was considered statistically significant. All data in this study were analyzed with STATA (version 14.0, MP).

Results

Table 1 reports the sociodemographic characteristics of urban residents in 2014 and 2016. The gender variables were consistent throughout the years: 4,245 male samples accounted for 52.90%, while 3,779 female samples accounted for 47.10%. The percentage of current smokers dropped from 27.39% in 2014 to 26.24% at the end of 2016, and the percentage of former smokers increased from 9.78% to 11.78%. The annual income of the urban residents showed an overall upward trend, increasing from 2761.93 US dollars in 2014 to 4807.02 US dollars in 2016. The education level of the

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urban residents was generally not high, and more than half of the subjects were graduates from middle school or high school. The prevalence of chronic disease in both 2014 and 2016 was approximately 20%. More than 60% of the respondents rated their health status as healthy.

Table 1 Characteristics of urban resident in 2014 and 2016, China

variables		2014 (N=8025)	2016 (N=8025)
Smoking status N(%)	Non smokers	5042(62.83)	4974(61.98)
	Current smokers	2198(27.39)	2106(26.24)
	Former smokers	785(9.78)	945(11.78)
Annual income(US dollars) (Mean±SD)		2761.93±4927.22	4807.02±9163.16
GDP per capita(US dollars) (Mean±SD)		8806.48±3535.47	9370.96±4215.79
Gender n(%)	Male	4245(52.90)	4245(52.90)
	Female	3779(47.10)	3779(47.10)
Agen(%)	<35	1288(16.05)	1035(12.90)
	35~	4439(55.31)	4322(53.86)
	⩾60	2298(28.64)	2668(33.25)
Marital status n(%)	Married	6974(86.92)	6977(86.94)
	not in marriage	1050(13.08)	1048(13.06)
Education level n(%)	Primary school and below	2866(35.71)	2866(35.71)
	Middle school and High school	4120（51.34）	4110（51.21）
	junior college and above	1039（12.95）	1049（13.07）
Self-rated health	poor	1143(14.24)	1193(14.87)

status n(%)	Average	1351(16.83)	1788(22.28)
	Healthy	5531(68.92)	5044(62.85)
Having chronic disease or not n(%)	Yes	1629(20.30)	1637(20.40)
	No	6396(79.70)	6388(79.60)
Health Insurance status n(%)	Yes	7304(91.01)	7359(91.7)
	No	721(8.98)	666(8.3)
Doing physical exercise or not n(%)	Yes	3861(48.11)	4290(53.46)
	No	4164(51.89)	3735(46.54)
Type of employment n(%)	unemployed	2771(34.53)	2929(36.50)
	manager	423(5.27)	582(7.25)
	professional and technical staff	497(6.19)	513(6.39)
	clerks and related personnel	512(6.38)	429(5.35)
	service staff	1194(14.88)	1053(13.12)
	production workers in agriculture, forestry, animal husbandry, fishery and water conservancy sectors	1212(15.10)	1185(14.77)
	operator of production and transportation equipment and related personnel	1299(16.19)	1124(14.01)
	other	117(1.46)	210(2.62)
Alcohol intake n(%)	Yes	1305(16.26)	1271(15.84)
	No	6720(83.74)	6754(84.16)

Exchange rate of the Chinese Yuan against US$ were6.14 and 6.64 in 2014 and 2016 based on China Statistical Yearbook, 2017. [21]

Table 2 analyzes the smoking status of Chinese urban residents with different characteristics. In 2014 and 2016, the current smoking prevalence for men was 54.23%

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and 51.67%, and the current smoking prevalence for women was 3.49% and 3.60%, respectively. In both years, the current smoking prevalence of the 35 ~ age group was the highest, accounting for 29.04% and 27.83%, respectively, and group aged 60 and above has the highest former smoking prevalence, which were 14.93% and 16.53%, respectively.

Table 2 Smoking status of different Chinese urban resident groups in 2014 and 2016

Year	variables		Non smokers	Current smokers	Former smokers
2014	Gender n(%)	Male	1017（26.90）	2050（54.23）	713（18.86）
		Female	4025（94.82）	148（3.49）	72（1.70）
	Age n(%)	<35	888（68.94）	336（26.09）	64（4.97）
		35~	2772（62.45）	1289（29.04）	378（8.52）
		⩾60	1382（60.14）	573（24.93）	343（14.93）
2016	Gender n(%)	Male	964（25.50）	1953（51.67）	863（22.83）
		Female	4010（94.46）	153（3.60）	82（1.93）
	Age n(%)	<35	703（67.08）	264（25.51）	68（6.57）
		35~	2683（62.08）	1203（27.83）	436（10.09）
		⩾60	1588（59.52）	639（23.95）	441（16.53）

Figure 1 shows the distribution of income levels for the different smoking status categories in 2014 and 2016. All urban residents were divided into 5 groups based on their annual income levels. The levels ranged from 1 to 5 and represented the population

groups from the lowest 20% income group to the top 20% income group, respectively. Our studies have shown that the percentage of high-income non-smokers rose from 17.22% in 2014 to 19.12% in 2016, while the percentage of low-income non-smokers decreased from 22.05% to 20.14%. The percentage of high-income current smokers decreased from 26.30% in 2014 to 22.46% in 2016, while the percentage of low-income current smokers rose from 14.56% to 19.66%. The percentage of high-income former smokers decreased from 20.25% in 2014 to 19.15% in 2016, and the percentage of low-income former smokers decreased from 22.04% to 20.00%.

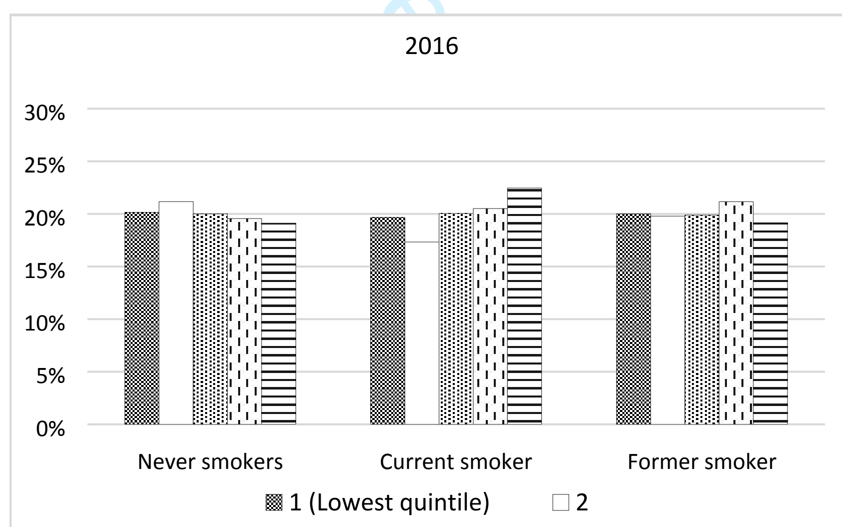

Figure1 Income distribution of urban resident in different smoking status in 2014 and

2016 , China

Table 3 presents the effects of smoking on the income of urban residents. Model 1 is an analysis of the income impact among all respondents. Models 2, 3, and 4 analyze the effects of smoking on the income level of different age groups, namely, young people (<35 years), middle-aged people (35 to 59 years old) and elderly people (≥60 years old). As is shown in model 1, smoking has a significant negative impact on income ($P < 0.05$). Compared to the annual income of non-smokers, the annual income of current smokers decreased by 37.70%, and the annual income of former smokers decreased by 44.00%. With improvements in education, the annual income of urban residents also increased. The income of residents with good self-rated health was significantly higher than that of urban residents with poor self-rated health. Smoking did not significantly affect the annual income of the young and elderly urban residents (see models 2 and 4), but it significantly reduced the income of middle-aged urban residents. In comparison to the annual income of non-smokers, the annual income of current smokers and former smokers decreased by 55.00% and 62.40%, respectively (see model 3).

Table 3 Analysis of the effect of smoking on income among Chinese urban residents

Variables	Model1 (Total population)	Model 2 (Young people)	Model 3 (Middle-aged people)	Model4 (Elderly people)
Smoking status (reference group: Non smokers)				
Current smokers	-0.377**	-0.129	-0.550***	-0.0991
	(-2.16)	(-0.65)	(-2.77)	(-0.23)
Fomer smokers	-0.440**	-0.107	-0.624***	-0.300

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	(-2.34)	(-0.48)	(-2.95)	(-0.66)
alcohol intake(reference group: no)	0.0110	0.0967	0.00461	-0.181
	(0.22)	(1.15)	(0.09)	(-1.61)
Gender (reference group: female)	0.455^{***}	0.335^{**}	0.595^{***}	0.285
	(3.68)	(2.48)	(4.01)	(0.97)
Age (reference group: <35)				
35~	-0.0643^{*}	-	-	-
	(-1.87)	-	-	-
⩾60	-0.781^{***}	-	-	-
	(-18.88)	-	-	-
Marital status	0.0557^{*}	0.0675	0.149^{***}	0.0286
(reference group: not in marriage)	(1.71)	(1.35)	(3.02)	(0.45)
Education (reference group:primary school and below)				
Middle school and high school	0.295^{***}	0.283^{***}	0.159^{***}	0.482^{***}
	(11.02)	(3.85)	(5.18)	(8.96)
Junior college and above	0.772^{***}	0.656^{***}	0.766^{***}	0.946^{***}
	(16.74)	(7.52)	(14.47)	(7.66)
Self rated health(reference group:poor)				
Average	0.130^{***}	-0.00716	0.0735^{*}	0.143^{**}
	(3.69)	(-0.07)	(1.81)	(2.32)
Healthy	0.166^{***}	0.0110	0.126^{***}	0.215^{***}
	(5.15)	(0.11)	(3.36)	(3.85)
Having chronic disease or not	0.0485^{*}	0.0191	-0.00160	0.105^{**}
(reference group: no)	(1.84)	(0.27)	(-0.05)	(2.31)
Insurance	-0.0682^{*}	0.0319	-0.0157	-0.274^{***}

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status	(-1.93)	(0.57)	(-0.39)	(-3.51)
(reference group: no)				
Doing physical exercise or not	0.0578***	0.0517	0.0358	0.163***
	(2.82)	(1.41)	(1.57)	(3.77)
(reference group: no)				
Type of employment(reference group: unemployed)				
manager	0.338***	0.613***	0.393***	0.190
	(7.37)	(7.50)	(8.38)	(1.23)
professional and technical staff	0.570***	0.680***	0.619***	0.820***
	(11.19)	(9.38)	(10.65)	(3.52)
clerks and related staff	0.557***	0.610***	0.602***	0.696***
	(11.48)	(8.14)	(11.26)	(4.41)
service staff	0.333***	0.516***	0.351***	0.344***
	(9.59)	(8.39)	(9.58)	(3.10)
production workers in Agriculture, forestry, animal husbandry, fishing and water conservancy sectors	-0.382***	-0.153	-0.170***	-0.649***
	(-11.28)	(-1.60)	(-4.27)	(-10.87)
operators of Production and transportation equipment and related personnel	0.576***	0.594***	0.585***	0.873***
	(15.83)	(9.03)	(15.34)	(6.52)
other	0.144**	0.346***	0.264***	-0.265
	(2.06)	(2.90)	(3.78)	(-1.25)

Ln GDP per capita	0.543***	0.652***	0.482***	0.630***
	(19.84)	(11.41)	(14.76)	(11.74)
Year (reference group: 2014)				
2016	1.036***	0.314***	0.472***	2.399***
	(59.74)	(10.91)	(25.58)	(65.86)
constant	2.516***	1.587**	3.365***	0.132
	(8.24)	(2.51)	(9.31)	(0.21)
N	16050	2576	8878	4596

t statistics in parentheses

** p < 0.1, ** p < 0.05, *** p < 0.01*

As shown in Table 4, the average poverty rate among Chinese urban residents in 2014 and 2016 was 15.33%, among which the poverty rate among former smokers, current smokers, and non-smokers were 16.01%, 12.59%, and 16.38%, respectively. The lowest income group had the highest poverty rate among all income groups. After eliminating the impact of smoking on income, which means raising the annual income of current smokers and former smokers by 37.70% and 44.00%, respectively, the poverty rate among urban residents was reduced to 13.63%, and the poverty rate among former smokers and current smokers was reduced to 10.10% and 8.25%, respectively.

Table 4 The poverty rate among Chinese urban residents at different smoking status and income levels

category	Income level	Non smokers	Current smokers	Former smokers	total
Impact of smoking on	Q1 (lowest 20% income)	61.35	54.90	58.84	59.60
	Q2	16.54	18.24	17.39	17.04
	Q3	0.00	0.00	0.00	0.00

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income retained	Q4	0.00	0.00	0.00	0.00
	Q5(top 20% income)	0.00	0.00	0.00	0.00
	Sub-total	16.38	12.59	16.01	15.33
Impact of smoking on income eliminated	Q1 (lowest 20% income)	61.35	48.30	53.04	57.41
	Q2	16.54	0.00	0.00	10.75
	Q3	0.00	0.00	0.00	0.00
	Q4	0.00	0.00	0.00	0.00
	Q5(top 20% income)	0.00	0.00	0.00	0.00
	Sub-total	16.38	8.25	11.10	13.63

Note: The poverty line criterion used was the 2010 poverty line standard of 2300 yuan per year . The nominal value was corrected with the consumer price index and transformed based on the poverty line measured by the constant price of 2014.

Discussion

This study revealed that smoking has a significant negative impact on the income of urban residents in China. The current annual income of current smokers was 37.70% less than that of non-smokers, while the income of former smokers was 44.00% less than that of non-smokers. After eliminating the impact of smoking on income, the poverty rate among urban residents was reduced by more than one percent, which means a population of approximately 13.11 million people were no longer in poverty.

This study revealed a higher impact of smoking on income than in previous studies. [9-11] Possible reasons are as follows. First, Chinese smokers consume an average of 15.2 cigarettes per day, [22] which reaches a heavy smoking level. [23] The greater the amount of smoking, the more serious health impacts there will be, which will result in a greater impact on personal income.[24-26] Second, in previous studies, smoking status was categorized into two groups, namely, smoking and nonsmoking, which mistakenly

categorized former smokers as non-smokers and thus underestimated the impact of smoking on income.

Smoking had different impacts on the personal income of people in different age groups. Smoking significantly reduced the income of middle-aged urban residents but did not significantly affect the income of young and elderly residents. The possible reasons are as follows. First, the harms of smoking have a cumulative and delayed effect, and the impacts of smoking on health are not yet evident in one's youth.[27] After smokers become middle aged, smoking gradually shows its negative impact on health.[28] Second, the current legal retirement age for Chinese workers is 60 for men and 50-55 for women.[29] Most people in age groups over 60 have retired with relatively stable retirement pensions. Therefore, there is little relation between their income and health status. Moreover, the relationship between health status and work hours as well as work ability also is minimally related to income.

From a policy perspective, reduction of smoking prevalence is not only a matter of public health concern but also closely related to the reduction of poverty. As the most populated middle-income country in the world, China has always aimed to reduce and eradicate poverty as a long-term task in the process of economic development.[30] To control the harm of tobacco, it is first recommended to make the most of the battle against poverty by integrating tobacco control strategies with national poverty alleviation policies. This effort will help overcome various economic and political obstacles in the implementation of existing tobacco control measures and facilitate the

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Chinese government's efforts to build a comprehensive, healthy society. Second, it is recommended to gradually increase the tax rate on tobacco and thereby increase cigarette retail prices to curb the tobacco epidemic. Raising tobacco taxes is the most cost-effective way to reduce tobacco use.[31] In addition, low-income groups are more sensitive to price changes; therefore, it is easier to reduce the demand for cigarettes among these groups.[32] Consequently, the low-income groups will receive most of the health and economic benefits of tax increases,[33] which is conducive to reducing the financial risks of low-income groups and the poverty rate. Third, it is recommended to cover smoking cessation treatment in medical insurance to alleviate the financial burden on smokers. Research has shown that patients with medical insurance are more willing to quit smoking than patients without medical insurance and that expanding health insurance coverage can improve the smoking cessation rate.[34] Fourth, it is recommended to promote publicity campaigns about tobacco harm and to encourage smokers to quit smoking as early as possible. The low awareness of Chinese residents about the harm of tobacco is to some degree related to the tobacco industry's use of "low tar" marketing strategies; therefore, it is recommended to stop implementing this deceptive tobacco marketing strategy.[35] Furthermore, the effect of warnings on tobacco packaging are not adequate. Studies have shown that the combination of text and pictures is more alarming than just a text warning.[36] It is therefore recommended to promote the use of warning pictures instead of the traditional text warnings on cigarette packages.

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The major contributions of this paper lie in the following three aspects. First, we have supplemented the empirical research conclusions on the relationship between smoking and resident income in China. Moreover, two-wave balance panel data can provide more data points, increase the degree of data freedom, reduce the degree of colinearity between explanatory variables, and thus improve the effectiveness of model estimation. It can also control individual heterogeneity, which helps improve the estimation accuracy.[37] Finally, the Hausman-Taylor model successfully addresses the problems of inconsistencies in the random effects model and the ineffectiveness of the fixed effects model by avoiding the disadvantages of the pooled regression model, which fails to consider the influence of individual differences. In addition, the Hausman-Taylor model can also overcome the endogeneity problems with the instrumental variables automatically generated from internal information in the model. [19]

Nevertheless, this study has some limitations. First, CHARLS is a retrospective self-reported survey, recall bias may be inevitable. Second, the study was limited to urban residents without consideration of the impact of smoking on the income of other populations.

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Competing interests None declared.

Patient consent Not required.

Data availability statement The personal level data of Chinese urban residents in our study are all from China Family Panel Studies (CFPS). The data users of CFPS are all over the world. Interested researchers may contact and apply for data via the following contact information: Email:isss.cfps@pku.edu.cn.

URL:http://charls.pku.edu.cn/. Interested researchers can request data by clicking the open the URL and follow instructions

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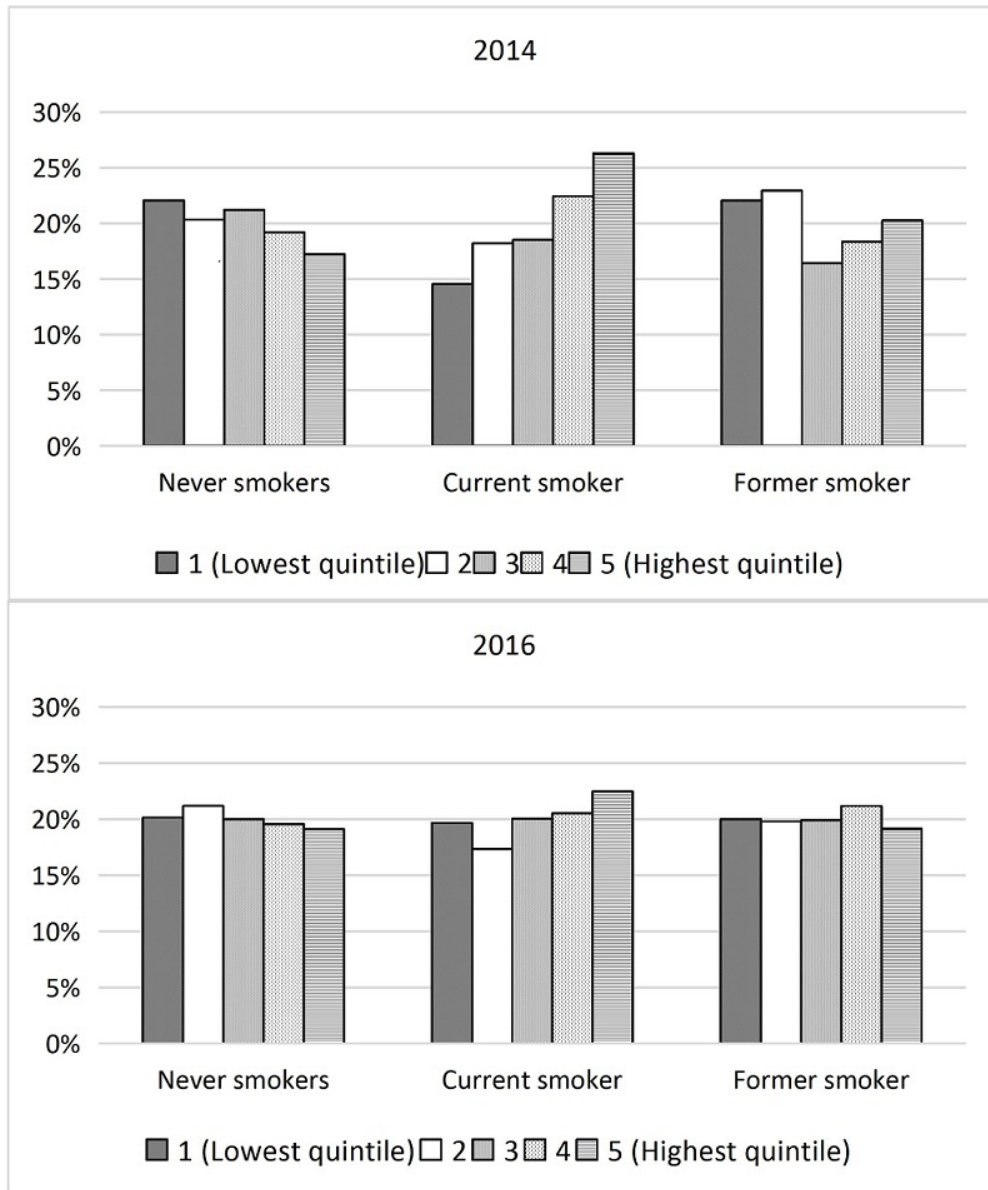

Figure1 Income distribution of urban resident in different smoking status in 2014 and 2016 , China

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Dear Editors:

Based on a national large-scale longitudinal database in China, this study used econometric models to estimate he impact of smoking on the income level of Chinese urban smokers. According to EQUATOR, no relevant checklist is available for our study type.

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Impact of smoking on the income level of Chinese urban residents: a 2-wave follow-up of the China Family Panel Study

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Keywords:	HEALTH ECONOMICS, Health economics < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH

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Impact of smoking on the income level of Chinese urban residents: a 2-wave follow-up of the China Family Panel Study

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Abstract

Objectives

This study attempts to analyze the impact of smoking on the income level of Chinese urban residents, to provide a reference for creating informed regulations on cigarette smoking.

Design

A population-based cohort study.

Method

Two waves of panel data in 2014 and 2016 from the China Family Panel Study (CFPS) were used. A total of 8025 urban adults were identified. The Hausman-Taylor model was used to analyze the theoretical relationship between smoking and income.

Results

The percentage of current smokers decreased from 27.39% (2014) to 26.24% (2016), while the percentage of former smokers rose from 9.78% to 11.78%. The results from the Hausman-Taylor model showed that current smokers and former smokers are associated with statistically significant decreased the income of urban residents of 37.70% and 44.00%, respectively, compared to that of non-smokers.. After eliminating the impact of smoking on income, the poverty rate among urban residents decreased from 15.33% to 13.63%.

Conclusions

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Smoking can significantly reduce the income of Chinese urban residents, resulting in immense negative impacts on Chinese society. Therefore, the government should raise the tax rate on tobacco, include smoking cessation treatment in medical insurance coverage, promote publicity campaigns on the awareness of tobacco hazards, and encourage smokers to quit smoking early.

Article Summary

- This study supplements the empirical research conclusions on the relationship between smoking and resident income in China.
- Two-wave balance panel data can improve the effectiveness of model estimation and the estimation accuracy.
- The Hausman-Taylor model can also overcome the endogeneity problems with the instrumental variables automatically generated from internal information in the model.
- The study was limited to urban residents without consideration of the impact of smoking on the income of other populations.

Introduction

China is the world's largest cigarette producer, manufacturer and consumer. As shown in the 2018 Global Adult Tobacco Survey (GATS) data, the current smoking prevalence of Chinese people aged 15 and above is 26.6%, and the population of smokers has reached 308 million.[1] Diseases caused by smoking, such as cardiovascular diseases, cancer, and chronic respiratory diseases, have become China's major health threats.[2-5]

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From 1990 to 2010, the number of deaths caused by smoking increased from 700,000 to 1.4 million.[6] Smoking-attributable deaths per year in China are predicted to reach 3 million by 2050 if the problem remains unchecked.[7]

It is well known that smoking negatively impacts people's health. Recently, an increasing number of scholars have been paying attention to the impact of smoking on personal income level.[8-12] Most research shows that smoking negatively affects income. Bockerman et al. noted the long-term negative impact of smoking on the income of Finnish males. [8] Auld concluded that Canadian smokers' income was 8% lower than the nonsmokers' income, and the smoking penalty rose to 24% after correcting for endogeneity. [9] Dutch smokers are paid approximately 10% less than non-smokers according to Van Ours' research results. [10] Lokshin et al. used data from the 2005 Albanian Living Standards Surveillance Survey and discovered that smokers earn 20% less than non-smokers.[11] In addition, a few studies have also shown less significant relationships between smoking and individual income. Lye et al. used 1995 Australian National Health Survey data to suggest that cigarette smoking did not significantly impact personal income. [12]

Previous studies have shown that three major reasons cause smoking to reduce income. First, smoking reduces the productivity of smokers. Kristein believes that smokers have more absent time and relatively lower productivity caused by smoking breaks or sick leave due to poor health.[13] Second, smokers have a relatively higher time preference, which means that they prefer current consumption to investment for the future. This

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preference may result in lower human capital investment in themselves, which in turn leads to lower income.[14] Third, smokers are personally less attractive than non-smokers. Smoking affects an individual's personal appearance and smell and, thus, reduces his or her personal attractiveness.[15]

There is a limited amount of related studies in China. Yin et al. concluded that smoking does not significantly affect resident income using data from the 1991-2006 China Health and Nutrition Survey. [16] The methodology adopted in this research involved a pooled regression model; however, this approach has limitations. The usage of panel data as the pooled data ignores the individual effects of research objects, which yields a research result that may not be robust. This study explores the possible impact of smoking on Chinese residents' income, with the aim to contribute to the methodologies used in previous Chinese studies, to accurately estimate the economic losses caused by smoking and to provide useful evidence for tobacco intervention policy making decisions.

Data and Model

Data Resources

The data in this study were derived from the China Family Panel Studies (CFPS) operated by the China Social Science Research Center (ISSS) of Beijing University.[17] CFPS is a national, large-scale, multidisciplinary social tracking survey project conducted every two years starting from 2010. CFPS adopted an implicit stratification strategy involving a multiphase and multilevel probability sampling method

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proportional to size, covering 25 provinces/municipalities/autonomous regions in the country (unsampled provinces/municipalities/autonomous regions include Hong Kong, Macau, Taiwan, Xinjiang, Tibet, Qinghai, Inner Mongolia, Ningxia and Hainan). Based on the regional distribution of sampling and the sampling method, this database is well representative and rigorous.

Face-to-face computer-assisted personal interviews involving demographic background, smoking habits, health status and personal income were conducted to ensure the objectivity and logicality of the data. This study used two waves of data that were publicly released by the CFPS. Since the CFPS questionnaire included rural residents' agricultural income in the household income data and it is difficult to accurately define the personal income of rural residents, the research subjects were limited to urban residents.

Ethics committee

Research ethical or governance approval is exempt for this study as no new data are being collected.

Patient and Public Involvement

All data in this study were derived from the CFPS database, no patient and the public were involved in the design or planning of this study.

Study sample

CFPS surveyed 10,874 and 9,942 urban individuals in 2014 and 2016, respectively, and 73.80% of individuals were successfully followed in the two waves. We eventually

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included 4,428 households and 8,025 respondents and constructed balanced panel data.

Measures

Smoking variables—Respondents were divided into groups of non-smokers, current smokers, and former smokers. The CFPS questionnaire asked, "Have you smoked in the last month?" When the respondent answered "yes", the individual was categorized as a "current smoker"; if the respondent answered “no”, he or she was then asked, "Have you ever smoked?" If the respondent answered "yes", the individual was considered to be a "former smoker"; if the answers to both questions were "no", the respondent was considered a nonsmoker.

Control variables—Demographic characteristics included gender (female or male), age(<35 years old,35-~years old,⩾60 years old), education (primary school and below, middle school and high school, or junior college and above), marital status (in a marriage: married/cohabiting or not in a marriage: single or separated/divorced/widowed), self-rated health status (poor, average, or healthy), chronic disease status (yes or no), health insurance status (yes or no), alcohol intake (yes or no), doing physical exercise or not (yes or no), type of employment (unemployed, manager, professional and technical personnel, clerks and related personnel, service personnel, workers in agricultural, forestry, animal husbandry, fishing and water conservancy sectors, production workers and transportation equipment operators and related personnel, Others), GDP per capita and the survey year (2014 or 2016).

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Dependent variable—The dependent variable in this study was the income of urban residents. The income variable was the total annual income of the respondents, including annual wages, overtime wages and bonuses, year-end bonuses, physical conversions received, income from a second occupation, retirement pensions, and net income from personal businesses. To eliminate the impact of price factors on income in different years, the consumer price index was used to correct the nominal value of income in 2016, which was converted to personal income measured at constant prices in 2014.

Poverty rate—The poverty line criterion used was the 2010 poverty line standard of 2300 yuan per year. The nominal value was corrected with the consumer price index and transformed based on the poverty line measured by the constant price of 2014. Measuring the extent of poverty, poverty rate represents the percentage of people below the poverty line in the total population.

Statistical analysis

In the study of the effects of smoking on income, data endogeneity is unavoidable. There are two causes for this endogeneity. One cause may be omitted variables that have an impact on outcome. For example, people with less self-control are more likely to develop a smoking habit. Self-control is an omitted variable that is rarely observed in research. Another possibility is that income level might affect smoking behaviors.[16] Smoking is addictive, and smoking behaviors are difficult to change. Analyzing them with the select panel data fixed effect model will result in a loss of samples with

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unchanged smoking status and, thus, fitting model parameters that deviate from reality.[18] To ensure the robustness of the analysis results, this study used the Hausman-Taylor model. The basic principle of the Hausman-Taylor model is to solve the endogeneity problems with the instrumental variables automatically generated from internal information in the model. In addition, the model can include variables that do not change over time and, thus, reduce sample loss.[19]

The basic econometric model of smoking impact on income was structured on Mincer's income equation by introducing smoking status variables into independent variables,[20] which were finally modified to obtain the Hausman-Taylor model.

$$\mathrm{Ln}(\mathrm{Income}_{it}) = \beta_0 + \beta_1 \mathrm{Smoking}_{it} + \beta_2 X_{it} + \eta Z_i + a_i + u_{it} \quad (1)$$

In the formula, $\mathrm{Ln}(\mathrm{Income}_{it})$ represents the logarithm of the annual income of individual i in t years; $\mathrm{smoking}_{it}$ is a dummy variable of the smoking status of the respondents; X_{it} is a control variable that changes over time, which includes age, education level, marital status, self-rated health status, chronic disease status, medical insurance status, alcohol consumption status, employment status, location, and survey year; Z_i is a control variable that remains unchanged over time, which includes gender; α_i indicates the differences between individuals and remains unchanged over time; and u_{it} is the error term. A semilogarithmic equation means that a change in the independent variable causes a percentage change in the dependent variable when other variables remain constant.

This study describes the sociodemographic characteristics (gender, age, education

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levels, marital status, etc.), health behaviors (including smoking status, alcohol intake, and doing physical exercise or not), and health status (Self-rated health status and Having chronic disease or not), Health Insurance status, type of employment, per capita GDP and income of Chinese urban residents in years 2014 and 2016 (see Table 1); Moreover, this study describes the smoking status among different characteristics groups (gender, age) of Chinese urban residents in 2014 and 2016 (see Table 2); In addition, it analyzes income distribution of urban resident in different smoking status (see Figure 1); It also analyzes the effect of smoking on income among Chinese urban residents; (see Table 3); Finally, it describes poverty rate in different smoking status (see Table 4).

A two-tailed p value of <0.05 was considered statistically significant. All data in this study were analyzed with STATA (version 14.0, MP).

Results

Table 1 reports the sociodemographic characteristics of urban residents in 2014 and 2016. The gender variables were consistent throughout the years: 4,245 male samples accounted for 52.90%, while 3,779 female samples accounted for 47.10%. The percentage of current smokers dropped from 27.39% in 2014 to 26.24% at the end of 2016, and the percentage of former smokers increased from 9.78% to 11.78%. The annual income of the urban residents showed an overall upward trend, increasing from 2761.93 US dollars in 2014 to 4807.02 US dollars in 2016. The education level of the urban residents was generally not high, and more than half of the subjects were

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graduates from middle school or high school. The prevalence of chronic disease in both 2014 and 2016 was approximately 20%. More than 60% of the respondents rated their health status as healthy.

Table 1 Characteristics of urban resident in 2014 and 2016, China

variables		2014 (N=8025)	2016 (N=8025)
Smoking status N(%)	Non smokers	5042(62.83)	4974(61.98)
	Current smokers	2198(27.39)	2106(26.24)
	Former smokers	785(9.78)	945(11.78)
Annual income(US dollars) (Mean±SD)		2761.93±4927.22	4807.02±9163.16
GDP per capita(US dollars) (Mean±SD)		8806.48±3535.47	9370.96±4215.79
Gender n(%)	Male	4245(52.90)	4245(52.90)
	Female	3779(47.10)	3779(47.10)
Agen(%)	<35	1288(16.05)	1035(12.90)
	35~	4439(55.31)	4322(53.86)
	⩾60	2298(28.64)	2668(33.25)
Marital status n(%)	Married	6974(86.92)	6977(86.94)
	not in marriage	1050(13.08)	1048(13.06)
Education level n(%)	Primary school and below	2866(35.71)	2866(35.71)
	Middle school and High school	4120（51.34）	4110（51.21）
	junior college and above	1039（12.95）	1049（13.07）
Self-rated health status	poor	1143(14.24)	1193(14.87)
	Average	1351(16.83)	1788(22.28)

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n(%)	Healthy	5531(68.92)	5044(62.85)
Having chronic disease or not	Yes	1629(20.30)	1637(20.40)
n(%)	No	6396(79.70)	6388(79.60)
Health Insurance status	Yes	7304(91.01)	7359(91.7)
n(%)	No	721(8.98)	666(8.3)
Doing physical exercise or not	Yes	3861(48.11)	4290(53.46)
n(%)	No	4164(51.89)	3735(46.54)
Type of employment n(%)	unemployed	2771(34.53)	2929(36.50)
	manager	423(5.27)	582(7.25)
	professional and technical staff	497(6.19)	513(6.39)
	clerks and related personnel	512(6.38)	429(5.35)
	service staff	1194(14.88)	1053(13.12)
	production workers in agriculture, forestry, animal husbandry, fishery and water conservancy sectors	1212(15.10)	1185(14.77)
	operator of production and transportation equipment and related personnel	1299(16.19)	1124(14.01)
	other	117(1.46)	210(2.62)
Alcohol intake	Yes	1305(16.26)	1271(15.84)
n(%)	No	6720(83.74)	6754(84.16)

Exchange rate of the Chinese Yuan against US$ were6.14 and 6.64 in 2014 and 2016 based on China Statistical Yearbook, 2017. [21]

Table 2 analyzes the smoking status of Chinese urban residents with different characteristics. In 2014 and 2016, the current smoking prevalence for men was 54.23% and 51.67%, and the current smoking prevalence for women was 3.49% and 3.60%,

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respectively. In both years, the current smoking prevalence of the 35 ~ age group was the highest, accounting for 29.04% and 27.83%, respectively, and group aged 60 and above has the highest former smoking prevalence, which were 14.93% and 16.53%, respectively.

Table 2 Smoking status of different Chinese urban resident groups in 2014 and 2016

Year	variables		Non smokers	Current smokers	Former smokers
2014	Gender n(%)	Male	1017（26.90）	2050（54.23）	713（18.86）
		Female	4025（94.82）	148（3.49）	72（1.70）
	Age n(%)	<35	888（68.94）	336（26.09）	64（4.97）
		35~	2772（62.45）	1289（29.04）	378（8.52）
		≥60	1382（60.14）	573（24.93）	343（14.93）
2016	Gender n(%)	Male	964（25.50）	1953（51.67）	863（22.83）
		Female	4010（94.46）	153（3.60）	82（1.93）
	Age n(%)	<35	703（67.08）	264（25.51）	68（6.57）
		35~	2683（62.08）	1203（27.83）	436（10.09）
		≥60	1588（59.52）	639（23.95）	441（16.53）

Figure 1 shows the distribution of income levels for the different smoking status categories in 2014 and 2016. All urban residents were divided into 5 groups based on their annual income levels. The levels ranged from 1 to 5 and represented the population groups from the lowest 20% income group to the top 20% income group, respectively.

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Our studies have shown that the percentage of high-income non-smokers rose from 17.22% in 2014 to 19.12% in 2016, while the percentage of low-income non-smokers decreased from 22.05% to 20.14%. The percentage of high-income current smokers decreased from 26.30% in 2014 to 22.46% in 2016, while the percentage of low-income current smokers rose from 14.56% to 19.66%. The percentage of high-income former smokers decreased from 20.25% in 2014 to 19.15% in 2016, and the percentage of low-income former smokers decreased from 22.04% to 20.00%.

Figure1 Income distribution of urban resident in different smoking status in 2014 and 2016 , China

Table 3 presents the effects of smoking on the income of urban residents. Model 1 is an analysis of the income impact among all respondents. Models 2, 3, and 4 analyze the effects of smoking on the income level of different age groups, namely, young people (<35 years), middle-aged people (35 to 59 years old) and elderly people (≥60 years old). As is shown in model 1, smoking has a significant negative impact on income ($P < 0.05$). Compared with the annual income of non-smokers, current smokers and former smokers are associated with statistically significant decreased the income of urban residents of 37.70% and 44.00%, respectively.With improvements in education, the annual income of urban residents also increased. The income of residents with good self-rated health was significantly higher than that of urban residents with poor self-rated health. Smoking did not significantly affect the annual income of the young and elderly urban residents (see models 2 and 4), but it significantly reduced the income of

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middle-aged urban residents. In comparison to the annual income of non-smokers, current smokers and former smokers are associated with statistically significant decreased the income of urban residents (see Model 3).

Table 3 Analysis of the effect of smoking on income among Chinese urban residents

Variables	Model1 (Total population)	Model 2 (Young people)	Model 3 (Middle-aged people)	Model4 (Elderly people)
Smoking status (reference group: Non smokers)				
Current smokers	-0.377**	-0.129	-0.550***	-0.0991
	(-2.16)	(-0.65)	(-2.77)	(-0.23)
Fomer smokers	-0.440**	-0.107	-0.624***	-0.300
	(-2.34)	(-0.48)	(-2.95)	(-0.66)
alcohol intake(reference group: no)	0.0110	0.0967	0.00461	-0.181
	(0.22)	(1.15)	(0.09)	(-1.61)
Gender (reference group: female)	0.455***	0.335**	0.595***	0.285
	(3.68)	(2.48)	(4.01)	(0.97)
Age (reference group: <35)				
35~	-0.0643*	-	-	-
	(-1.87)	-	-	-
⩾60	-0.781***	-	-	-
	(-18.88)	-	-	-
Marital status	0.0557*	0.0675	0.149***	0.0286
(reference group: not in marriage)	(1.71)	(1.35)	(3.02)	(0.45)
Education (reference group:primary school and below)				

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Middle school and high school	0.295***	0.283***	0.159***	0.482***
	(11.02)	(3.85)	(5.18)	(8.96)
Junior college and above	0.772***	0.656***	0.766***	0.946***
	(16.74)	(7.52)	(14.47)	(7.66)
Self rated health(reference group:poor)				
Average	0.130***	-0.00716	0.0735*	0.143**
	(3.69)	(-0.07)	(1.81)	(2.32)
Healthy	0.166***	0.0110	0.126***	0.215***
	(5.15)	(0.11)	(3.36)	(3.85)
Having chronic disease or not	0.0485*	0.0191	-0.00160	0.105**
	(1.84)	(0.27)	(-0.05)	(2.31)
(reference group: no)				
Insurance status	-0.0682*	0.0319	-0.0157	-0.274***
(reference group: no)	(-1.93)	(0.57)	(-0.39)	(-3.51)
Doing physical exercise or not	0.0578***	0.0517	0.0358	0.163***
	(2.82)	(1.41)	(1.57)	(3.77)
(reference group: no)				
Type of employment(reference group: unemployed)				
manager	0.338***	0.613***	0.393***	0.190
	(7.37)	(7.50)	(8.38)	(1.23)
professional and technical staff	0.570***	0.680***	0.619***	0.820***
	(11.19)	(9.38)	(10.65)	(3.52)
clerks and related staff	0.557***	0.610***	0.602***	0.696***
	(11.48)	(8.14)	(11.26)	(4.41)
service staff	0.333***	0.516***	0.351***	0.344***
	(9.59)	(8.39)	(9.58)	(3.10)
production	-0.382***	-0.153	-0.170***	-0.649***

workers in Agriculture, forestry, animal husbandry, fishing and water conservancy sectors	(-11.28)	(-1.60)	(-4.27)	(-10.87)
operators of Production and transportation equipment and related personnel	0.576***	0.594***	0.585***	0.873***
	(15.83)	(9.03)	(15.34)	(6.52)
other	0.144**	0.346***	0.264***	-0.265
	(2.06)	(2.90)	(3.78)	(-1.25)
Ln GDP per capita	0.543***	0.652***	0.482***	0.630***
	(19.84)	(11.41)	(14.76)	(11.74)
Year (reference group: 2014)				
2016	1.036***	0.314***	0.472***	2.399***
	(59.74)	(10.91)	(25.58)	(65.86)
constant	2.516***	1.587**	3.365***	0.132
	(8.24)	(2.51)	(9.31)	(0.21)
N	16050	2576	8878	4596

t statistics in parentheses

** p < 0.1, ** p < 0.05, *** p < 0.01*

As shown in Table 4, the average poverty rate among Chinese urban residents in 2014 and 2016 was 15.33%, among which the poverty rate among former smokers, current smokers, and non-smokers were 16.01%, 12.59%, and 16.38%, respectively. The lowest income group had the highest poverty rate among all income groups. After eliminating the impact of smoking on income, which means raising the annual income

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4 of current smokers and former smokers by 37.70% and 44.00%, respectively, the
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7 poverty rate among urban residents was reduced to 13.63%, and the poverty rate among
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9 former smokers and current smokers was reduced to 10.10% and 8.25%, respectively.
10
11
12 Table 4 The poverty rate among Chinese urban residents at different smoking status
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14 and income levels
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category	Income level	Non smokers	Current smokers	Former smokers	total
Impact of smoking on income retained	Q1 (lowest 20% income)	61.35	54.90	58.84	59.60
	Q2	16.54	18.24	17.39	17.04
	Q3	0.00	0.00	0.00	0.00
	Q4	0.00	0.00	0.00	0.00
	Q5(top 20% income)	0.00	0.00	0.00	0.00
	Sub-total	16.38	12.59	16.01	15.33
Impact of smoking on income eliminated	Q1 (lowest 20% income)	61.35	48.30	53.04	57.41
	Q2	16.54	0.00	0.00	10.75
	Q3	0.00	0.00	0.00	0.00
	Q4	0.00	0.00	0.00	0.00
	Q5(top 20% income)	0.00	0.00	0.00	0.00
	Sub-total	16.38	8.25	11.10	13.63

46 *Note: The poverty line criterion used was the 2010 poverty line standard of 2300 yuan*
47 *per year. The nominal value was corrected with the consumer price index and*
48 *transformed based on the poverty line measured by the constant price of 2014.*
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50 **Discussion**
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53 This study revealed that smoking has a significant negative impact on the income of
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56 urban residents in China. The current annual income of current smokers was 37.70%
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59 less than that of non-smokers, while the income of former smokers was 44.00% less
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than that of non-smokers. After eliminating the impact of smoking on income, the poverty rate among urban residents was reduced by more than one percent, which means a population of approximately 13.11 million people were no longer in poverty.

This study revealed a higher impact of smoking on income than in previous studies. [9-11] Possible reasons are as follows. First, Chinese smokers consume an average of 15.2 cigarettes per day, [22] which reaches a heavy smoking level. [23] The greater the amount of smoking, the more serious health impacts there will be, which will result in a greater impact on personal income.[24-26] Second, in previous studies, smoking status was categorized into two groups, namely, smoking and nonsmoking, which mistakenly categorized former smokers as non-smokers and thus underestimated the impact of smoking on income.

Smoking had different impacts on the personal income of people in different age groups. Smoking significantly reduced the income of middle-aged urban residents but did not significantly affect the income of young and elderly residents. The possible reasons are as follows. First, the harms of smoking have a cumulative and delayed effect, and the impacts of smoking on health are not yet evident in one's youth.[27] After smokers become middle aged, smoking gradually shows its negative impact on health.[28] Second, the current legal retirement age for Chinese workers is 60 for men and 50-55 for women.[29] Most people in age groups over 60 have retired with relatively stable retirement pensions. Therefore, there is little relation between their income and health status. Moreover, the relationship between health status and work hours as well as work ability also is minimally related to income.

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From a policy perspective, reduction of smoking prevalence is not only a matter of public health concern but also closely related to the reduction of poverty. As the most populated middle-income country in the world, China has always aimed to reduce and eradicate poverty as a long-term task in the process of economic development.[30] To control the harm of tobacco, it is first recommended to make the most of the battle against poverty by integrating tobacco control strategies with national poverty alleviation policies. This effort will help overcome various economic and political obstacles in the implementation of existing tobacco control measures and facilitate the Chinese government's efforts to build a comprehensive, healthy society. Second, it is recommended to gradually increase the tax rate on tobacco and thereby increase cigarette retail prices to curb the tobacco epidemic. Raising tobacco taxes is the most cost-effective way to reduce tobacco use.[31] In addition, low-income groups are more sensitive to price changes; therefore, it is easier to reduce the demand for cigarettes among these groups.[32] Consequently, the low-income groups will receive most of the health and economic benefits of tax increases,[33] which is conducive to reducing the financial risks of low-income groups and the poverty rate. Third, it is recommended to cover smoking cessation treatment in medical insurance to alleviate the financial burden on smokers. Research has shown that patients with medical insurance are more willing to quit smoking than patients without medical insurance and that expanding health insurance coverage can improve the smoking cessation rate.[34] Fourth, it is recommended to promote publicity campaigns about tobacco harm and to encourage smokers to quit smoking as early as possible. The low awareness of Chinese residents

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about the harm of tobacco is to some degree related to the tobacco industry's use of "low tar" marketing strategies; therefore, it is recommended to stop implementing this deceptive tobacco marketing strategy.[35] Furthermore, the effect of warnings on tobacco packaging are not adequate. Studies have shown that the combination of text and pictures is more alarming than just a text warning.[36] It is therefore recommended to promote the use of warning pictures instead of the traditional text warnings on cigarette packages.

The major contributions of this paper lie in the following three aspects. First, we have supplemented the empirical research conclusions on the relationship between smoking and resident income in China. Moreover, two-wave balance panel data can provide more data points, increase the degree of data freedom, reduce the degree of colinearity between explanatory variables, and thus improve the effectiveness of model estimation. It can also control individual heterogeneity, which helps improve the estimation accuracy.[37] Finally, the Hausman-Taylor model successfully addresses the problems of inconsistencies in the random effects model and the ineffectiveness of the fixed effects model by avoiding the disadvantages of the pooled regression model, which fails to consider the influence of individual differences. In addition, the Hausman-Taylor model can also overcome the endogeneity problems with the instrumental variables automatically generated from internal information in the model. [19]

Nevertheless, this study has some limitations. First, CHARLS is a retrospective self-reported survey, recall bias may be inevitable. Second, the study was limited to urban

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residents without consideration of the impact of smoking on the income of other populations.

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Contributors Conceptualization: Lian Yang; Formal analysis: Zhengzhong Mao; Methodology: Han Wei, Zhigang Zhong,Shiyao Huang; Writing – original draft:Han Wei, Zhigang Zhong; Writing – review & editing: Lian Yang, Han Wei, Zhengzhong Mao,Tingting Yao.

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Competing interests None declared.

Patient consent Not required.

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Data availability statement The personal level data of Chinese urban residents in our study are all from China Family Panel Studies (CFPS). The data users of CFPS are all over the world. Interested researchers may contact and apply for data via the following contact information: Email:isss.cfps@pku.edu.cn.

URL:http://charls.pku.edu.cn/. Interested researchers can request data by clicking the open the URL and follow instructions

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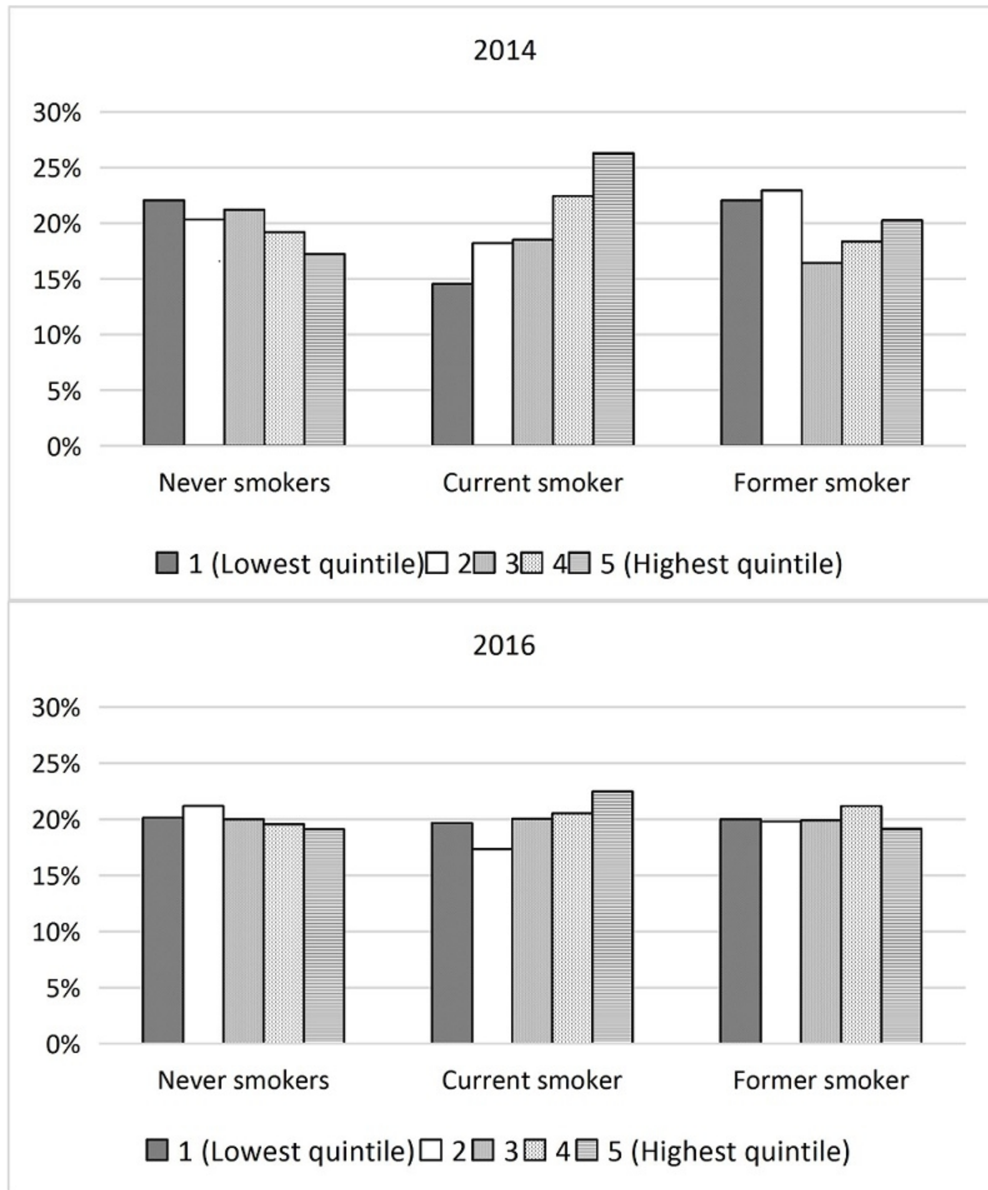

Figure1 Income distribution of urban resident in different smoking status in 2014 and 2016 , China

67x80mm (300 x 300 DPI)

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Dear Editors:

Based on a national large-scale longitudinal database in China, this study used econometric models to estimate he impact of smoking on the income level of Chinese urban smokers. According to EQUATOR, no relevant checklist is available for our study type.

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