Prevalence, frequency, intensity, and location of cigarette use among adolescents in China from 2013–14 to 2019: Findings from two repeated cross-sectional studies

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Summary

Background The burden of disease caused by tobacco use is a grave public health concern in China. Preventing smoking initiation among adolescents will lower the prevalence of adult tobacco use later. Surveillance of tobacco use among adolescents helps set priorities in developing tobacco control policies. We aim to ascertain the prevalence and differences of cigarette use across sex, grade, and region among middle and high school students in 2019 and associated changes from 2013-14 to 2019 among middle school students.

Methods Using a multistage stratified cluster-randomized sampling design with national and provincial representativeness, we conducted two school-based cross-sectional surveys in 2013–14 and in 2019. A total of 155 117 middle school students in grades 7–9 in 2013-14 and 288 192 middle and high school students in grades 7–12 in 2019 were interviewed. Self-reported experimental and current (past 30-day) cigarette use among middle school and high school students; frequent use (≥20 days in the past 30 days) and intensity (>20 cigarettes per day) of smoking among current cigarette users; and location of smoking among current cigarette users were investigated. All estimates were weighted based on the complex sampling design.

Findings The 2013-14 survey (overall response rate: 98.1%) included 155 117 middle school students (47.1% girl). The 2019 survey (overall response rate: 98.7%) included 147 270 middle school students (46.5% girl), 106 432 academic high school students (50.8% girl) and 34 490 vocational high school students (43.8% girl). In 2019, the prevalence rate of experimental and current cigarette use was 12.9% and 3.9% for middle school students, 21.6% and 5.6% for academic high school students, and 30.3% and 14.7% for vocational high school students, respectively, with large sex and regional differences. The prevalences of smoking on 20 or more days and daily cigarette use in the past 30 days were higher in vocational high school (5.9%, 4.1%) than in academic high school (1.8%, 1.2%) and middle school (0.7%, 0.5%), and higher among boys than girls. The proportions of current cigarette users smoking more than 20 cigarettes per day in the past 30 days for girls were higher than for boys in academic high school. Students usually smoke at school and at home. Boys were more likely to use cigarettes in an internet cafe, while girls often smoked at social venues. From 2013-14 to 2019, the prevalences of experimental and current cigarette use declined by 5.0% and 2.0% (percentage points), respectively, among middle school students but increased by 1.4% and 0.5% (percentage points) among rural girls. Among current cigarette users in middle school students, the proportions of

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heavy cigarette use (>20 cigarettes per day) have increased by 1.8 percentage points, mainly among boys, by 2.2% (percentage points).

Interpretation From 2013–14 to 2019, the prevalences of experimental and current cigarette use among middle school students decreased overall but increased among rural girls, while the intensity of cigarette use rose among boys. Cigarette use among Chinese adolescents differs across sex and regions, with higher rates among boys, in rural areas, and in the Western region (low socioeconomic status). Smoking is much more prevalent in vocational high schools than the other settings. Effective targeted tobacco control interventions among adolescents are urgently needed in China.

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Keywords: Adolescent; Cigarette use; Prevalence; China

Research in context

Evidence before this study

We searched PubMed and Chinese databases, including China National Knowledge Infrastructure and Wan Fang database, until June 2021. A collection of terms were used in the literature search, including tobacco ("tobacco" or "cigarette" or "smoke"), subjects ("youth" or "adolescent" or "teenager"), and geographic locations ("China" or "Chinese"). Previously published reports on tobacco use were reviewed as well. Over the past three decades, several surveys on adolescents' tobacco use have been conducted in China. In 1998, Professor Gonghuan Yang surveyed 24000 children aged 11–20 years in 16 provinces about tobacco use. The Global Youth Tobacco Survey (GYTS) was conducted in 4 provinces among students aged 13–15 years in 1999. Both surveys were not nationally representative. In 2013–14, the Chinese Center for Disease Control and Prevention carried out nationally representative GYTS among middle school students aged 13–15 but not among high school students. A study based on the National Health Services Survey reported that the smoking rate among smokers aged 15–24 years had increased from 8.3% in 2003 to 12.5% in 2013. According to China National Adult Tobacco Survey, the smoking rate among smokers aged 15–24 has increased from 17.9% in 2010 to 18.6% in 2018. Although changes in the smoking rate among those aged 15–24 years have been reported, tobacco use and initiation among minors have not been investigated in China.

Added value of this study

Our study investigated cigarette use among Chinese adolescents in 2019 and the changes in cigarette use from 2013–14 to 2019 among middle school students. We found that the prevalence of self-reported current cigarette use was 14.7%, 8.6%, and 3.9% among vocational high school students, academic high school students, and middle school students in 2019, respectively, with large sex and regional differences. The prevalence of self-reported current cigarette use decreased by 2.0% (percentage points) from 2013–14 to 2019 among middle school students overall but increased by 0.5% (percentage points) among girls in rural areas. The proportion of heavy cigarette use (>20 cigarettes per day) among current users increased by 2.2% (percentage points) among middle school boys.

Implications of all the available evidence

Tobacco use, a threat to health among adolescents, was more prevalent among Chinese high school students than middle school students, particularly vocational high school students. From 2013–14 to 2019, the prevalence rate of self-reported current cigarette use has decreased among Chinese middle school students but increased among girls in rural areas. The Chinese government should implement more effective tobacco control measures for adolescents, especially among vocational high school students and rural girls.

Introduction

Tobacco use is a significant threat to health and development, and the number of smokers and cigarettes consumed worldwide have increased significantly in the past decades.[1] As the country with the largest tobacco production and consumption in the world,[2,3] tobacco use is prevalent among Chinese adults (about 308 million smokers) and continues to be above the global average,[4,5] with a low rate of successful quitting.[6] To meet the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) and achieve the United Nations Sustainable Development Goals (SDGs),[7,8] the Chinese government has taken a series of measures, such as indoor smoking ban in all

public and work spaces, smoke-free legislation, and tobacco taxation.[9] China launched the Healthy China 2030 Action Plan, aiming to decrease adult smoking prevalence to 20% by 2030.[4]

The prevalence rate of tobacco use in China remained high, and it has increased among adolescents aged 15–24 years.[10] In China, 77.9% of current smokers started smoking at puberty.[10] Preventing tobacco use initiation during adolescence will mitigate and control the adult tobacco epidemic in China. A series of measures, laws, and regulations have been implemented in China to prevent and reduce the harmful effects of tobacco on youth, such as creating smoke-free school campuses nationwide,[11] health promotion and education on tobacco control,[12] banning tobacco sales to minors or around schools,[13] and prohibiting tobacco advertising in public space and tobacco advertising to minors.[14] To evaluate and effectively implement tobacco control policies in China, nationwide surveillance of adolescents smoking is essential.

Based on the framework of the Global Youth Tobacco Survey (GYTS), the Chinese Center for Disease Control and Prevention (China CDC) conducted the first round of the survey with national and provincial representativeness in 2013–14 (GYTS-China) among middle school students (grade 7–9). In 2019, China CDC implemented the National Youth Tobacco Survey (NYTS) with a design similar to the 2013–14 GYTS-China among middle school (grade 7–9) and high school students (grade 10–12), including academic and vocational high school students. In China, academic high school students prepare for the college entrance examination, and those who have failed the entrance examination or chose not to enter an academic high school go to a vocational high school.[15,16] In vocational high schools, students acquire technical, professional, and operational skills to prepare for a specific occupation.

Using the two surveys, this study aims to investigate tobacco use among Chinese middle school and high school students, including the rate, frequency, intensity, and locations of cigarette use, and the differences in the rates across sex, grade, region, and socioeconomic status; and describes changes of cigarette use from 2013–14 to 2019 among middle school students.

Methods

Data source and participants

Both 2013–14 GYTS-China and 2019 China NYTS were cross-sectional, school-based (public or private), paper-and-pencil questionnaire administered surveys that were implemented in 31 provinces of mainland China. The two surveys used a three-stage stratified cluster random sample design. Primary sampling units (PSUs) (each PSU corresponding to one county or an equivalent urban district) were selected from each province stratified by urban-rural area with a probability proportional to (population) size sampling (PPS). In each province, the number of PSUs was determined based on the population in 2013–14. Eight PSUs were selected when the population size is less than or equal to 30 million, and 2 PSUs will be added for every 15 million population increase. Ten PSUs (5 counties and 5 districts) were selected in each province in 2019. A total of 336 PSUs in 2013–14 and 347 PSUs in 2019 were used nationwide. The geographical distribution of PSUs in the two surveys is shown in eFigure 1 in the Supplement.

Second, schools were selected in each PSU by PPS sampling proportional to student size. In each PSU, 3 middle schools were selected in 2013–14, while 3 middle schools, 2 academic high schools and 1 vocational high school were selected in 2019. To be included in the sampling frame, a school must have more than 120 students. Third, one class in each grade of a selected school was randomly identified, and all the students in the class were interviewed. Each class must have more than 40 students. Otherwise, it would be combined with other classes. The sampling was carried out by China CDC in collaboration with local health and education authorities. The National Health Commission of China approved both surveys, and the protocols were reviewed and approved by the Institutional Review Board of China CDC. School officials and respondents provided oral consent to participate before the interview.

Procedures

Structured paper-based questionnaires with no logical skips were used, and quality control was implemented for both surveys. Before the field interview, all the field interviewers and quality control personnel had been trained on how to conduct field interviews. During the interview, the interviewers explained in detail about the informed consent to the respondents. The respondents completed the questionnaire in about 10–15 min without the presence of a teacher. Quality control personnel checked for the completeness of all responses and then submitted them to the data administrators. After the interview, responses were transcribed into electronic data. The data were further processed to determine whether to correct, delete, or be treated as missing values based on other information in the responses.

The questionnaire collects information on the school, grade, class, and individual, as well as on tobacco use, e-cigarette use, addiction, cessation, secondhand smoke exposure, tobacco product availability and price, tobacco control campaigns, tobacco advertisements and promotion, and tobacco perception and attitudes. The 2013–14 GYTS-China and 2019 NYTS contain 62 and 45 questions, respectively. The questions relevant to the present study are in the

Supplement. The details for the two surveys have been published elsewhere.[17,18]

Experimental smokers were those who had smoked cigarettes in the past, including those who may have taken only one or two puffs. Current smokers were those who had smoked a cigarette at least one day in the past 30 days. Among current smokers of cigarette use, smoking frequency was dichotomized as use on 20 or more days (frequent cigarette use) or fewer than 20 days in the past 30 days, and daily use or not daily use in the past 30 days. Smoking intensity was dichotomized as smoking 20 or fewer cigarettes per day or more than 20 cigarettes per day (heavy cigarette use). Smoking places for current cigarette users were classified as home, internet cafe, school, friends' home, social venues, restaurant, and other places.

Statistical analysis

A three-step weighting scheme based on a complex sampling design was used. For parameter estimation, all the weighting was done within each province and stratified by urban and rural.[19] First, the base weight of each class was calculated by multiplying the sample weights of PSU (reciprocal of sampling probability by population), schools (reciprocal of sampling probability by the number of students), and classes (total number of classes for this grade). Second, non-response adjustment weights were computed by multiplying the reciprocals of the response rates of PSUs, schools, classes, and students. Third, post-stratification correction weights were calculated according to the urban-rural, school type (middle school, academic high school, or vocational high school), sex (girl or boy), and grade composition of the students in each province. The final weight of each respondent was obtained by multiplying the base weight with the non-response adjustment weight and the post-stratification adjustment weight. The point estimate and 95% confidence interval (CIs) for each parameter were calculated using the final weights and reported in this study. Linear regression models were applied to test the absolute changes in prevalence between two years, and the Jackknife replicate method was used for calculating the relative percentage changes. A 2-tailed P value of <0.05 was considered statistically significant. All analyses were done with SAS (version 9.4; SAS Institute, Inc. Cary, NC, USA).

Role of the funding source

No funding sources to report.

Results

Sociodemographic characteristics

A total of 155 117 middle school students participated in the 2013–14 GYTS-China (overall response rate: 98.1%). Of these, 47.1% were girls, and 27.9% were from urban areas. The distribution of participants was similar in terms of grade and socioeconomic status. A total of 288 192 students participated in the 2019 China NYTS (overall response rate: 98.7%), including 147 270 middle school students with 46.5% girls and 36.3% from urban areas, 106 432 academic high school students with 50.8% girls and 36.8% from urban areas, and 34 490 vocational high school students with 43.8% girls and 47.6% from urban areas. The distribution of participants in the 2013–14 GYTS-China and the 2019 China NYTS was similar in grade and socioeconomic status (Table 1). Sociodemographic characteristics across 31 provinces in the 2013–14 GYTS-China and 2019 China NYTS presented in eTable 2–9 in the Supplement. The unweighted sample size and the response rates at each stage are in eTable 1 in the Supplement.

Experimental use and current use of cigarette

In 2019, an estimated 12.9% and 3.9% of middle school students reported experimental and current cigarette use, higher in boys (17.9% and 5.8%) than girls (7.2% and 1.8%) and higher in rural (15.2% and 4.8%) than urban (9.0% and 2.3%) settings. Cigarette use was more prevalent in higher grades and regions with lower socioeconomic status. The rates of experimental and current cigarette use were 21.6% and 5.6%, higher in boys (33.6% and 10.0%) than girls (10.2% and 1.4%) for academic high school students, and 30.3% and 14.7% with higher rates in boys (43.2% and 23.3%) than girls (14.0% and 3.7%) for vocational high school students. There were no significant grade differences in academic high school students, nor urban-rural, socioeconomic status, and grade differences among vocational high school students. Cigarette use was more prevalent among students with more pocket money per week. The rates of experimental and current cigarette use were higher among students whose parents both smoked than when either or neither of their parents smoked. As the number of smokers among friends increases, so does the rates of experimental and current cigarette use among students, with the largest increase in vocational high school and up to 65.4% (Table 2). Experimental and current cigarette uses among middle and high school students by sex are in eTable 10 in the Supplement. Provincial differences in experimental and current cigarette use exist, more prevalent in the Southwest (Tibet, Yunnan, and Guizhou) and the South-central (Hainan, Guangxi, and Hunan), as well as Heilongjiang and Qinghai for middle school and academic high school students. Meanwhile, among vocational high school students, the rates of experimental and current cigarette use were higher in the South (Yunnan, Qinghai, and Guizhou) and the North (Jilin, Heilongjiang, and Inner Mongolia) (eFigure 2).

	Middle school students (2013−14)		Middle school students (2019)		High school students (2019)			
					Academic high school		Vocational high school	
characteristics	Unweighted, No.	Weighted % (95% CI)	Unweighted, No.	Weighted % (95% CI)	Unweighted, No.	Weighted % (95% CI)	Unweighted, No.	Weighted % (95% CI)
Total	155 117		147 270		106 432		34 490	
Sex								
Girls	74 760	47.1 (46.5-47.7)	76 492	46.5 (46.0-46.9)	55 806	50.8 (49.7-51.8)	16 363	43.8 (40.0-47.6)
Boys	80 357	52.9 (52.3-53.5)	70 778	53.5 (53.1-54.0)	50 626	49.2 (48.2-50.3)	18 127	56.2 (52.4-60.0)
Residence								
Urban	70 461	27.9 (26.0-29.8)	77 317	36.3 (34.1-38.5)	57 940	36.8 (34.2-39.4)	17 797	47.6 (43.1-52.2)
Rural	84 656	72.1 (70.2-74.0)	69 953	63.7 (61.5-65.9)	48 492	63.2 (60.6-65.8)	16 693	52.4 (47.8-56.9)
Socioeconomic status*								
High (Eastern)	56 819	36.6 (34.4-38.8)	50 222	37.7 (35.4-39.9)	35 405	35.6 (33.0-38.2)	12 607	37.1 (30.2-43.9)
Medium (Central)	44 718	32.3 (30.3-34.3)	46 891	33.1 (30.7-35.5)	34 891	32.9 (30.6-35.2)	11 592	31.4 (26.1-36.8)
Low (Western)	53 580	31.1 (29.1-33.1)	50 157	29.3 (27.2-31.3)	36 136	31.5 (29.1-33.9)	10 291	31.5 (26.0-37.0)
Grade								
7^{th}	52 729	33.1 (32.5-33.7)	49 187	34.8 (34.2-35.3)				
8^{th}	52 084	33.3 (32.9-33.7)	49 774	33.5 (33.1-33.9)				
9^{th}	50 304	33.6 (32.9-34.4)	48 309	31.7 (31.2-32.3)				
10^{th}					36320	33.4 (32.6-34.2)	12984	35.7 (32.2-39.2)
11^{th}					35560	33.3 (32.7-33.9)	12450	32.9 (30.5-35.2)
12^{th}					34552	33.3 (32.6-34.0)	9056	31.4 (27.3-35.6)

***Table 1*: Sociodemographic characteristics of middle school and high school students in China, 2013−14 and 2019.**

Abbreviation: CI, confidence interval.

* Eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan. Central region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan. Western region includes Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia, Guangxi.

	Experimental use[a]					Current use[b]				
	2013–14		2019		Absolute change, % (95% CI)	2013–14		2019		Absolute change, % (95% CI)
	Unweighted, No	Weighted % (95% CI)	Unweighted, No	Weighted % (95% CI)		Unweighted, No	Weighted % (95% CI)	Unweighted, No	Weighted % (95% CI)	
Middle school students										
Total	24643	17.9 (16.9–18.9)	16470	12.9 (12.0–13.9)	−5.0 (−6.3∼−3.6)	8151	5.9 (5.4–6.5)	4959	3.9 (3.4–4.4)	−2.0 (−2.8∼−1.2)
Sex										
Girls	5204	7.1 (6.4-7.8)	4506	7.2 (6.5-7.9)	0.2 (−0.8∼1.2)	1164	1.6 (1.3-1.8)	1085	1.8 (1.5-2.1)	0.2 (−0.2∼0.6)
Boys	19439	27.8 (26.4-29.2)	11964	17.9 (16.6-19.2)	−9.9 (−11.8∼−7.9)	6987	9.9 (9.0-10.8)	3874	5.8 (5.0-6.5)	−4.1 (−5.3∼−2.9)
Residence										
Urban	9880	14.7 (13.3-16.1)	6899	9.0 (8.1-9.9)	−5.7 (−7.4∼−4.0)	2808	3.9 (3.4-4.5)	1848	2.3 (1.9-2.6)	−1.7 (−2.4∼−1.0)
Rural	14763	19.1 (17.8-20.4)	9571	15.2 (13.6-16.6)	−3.9 (−5.8∼−2.0)	5343	6.7 (5.9-7.4)	3111	4.8 (4.1-5.6)	−1.8 (−2.9∼−0.8)
Socioeconomic status*										
High (Eastern)	6889	13.2 (11.9-14.6)	4485	9.2 (8.1-10.4)	−4.0 (−5.9∼−2.2)	1882	3.6 (3.0-4.3)	1267	2.5 (2.0-2.9)	−1.2 (−2.0∼−0.4)
Medium (Central)	7254	19.0 (17.0-20.9)	5379	13.4 (11.9-14.8)	−5.6 (−8.1∼−3.1)	1997	5.5 (4.3-6.6)	1342	3.4 (2.8-4.0)	−2.1 (−3.4∼−0.8)
Low (Western)	10500	22.2 (20.4-24.0)	6606	17.3 (15.1-19.5)	−5.0 (−7.8∼−2.1)	4272	9.0 (8.0-10.0)	2350	6.3 (4.9-7.8)	−2.7 (−4.5∼−0.9)
Grade										
7th	5609	11.6 (10.7-12.6)	3454	8.1 (7.2-9.0)	−3.5 (−4.8∼−2.3)	1697	3.5 (3.0-4.1)	874	2.2 (1.7-2.7)	−1.3 (−2.1∼−0.6)
8th	8525	18.6 (17.4-19.8)	5830	13.5 (12.3-14.7)	−5.1 (−6.8∼−3.4)	2875	6.3 (5.7-6.9)	1796	4.2 (3.4-4.9)	−2.1 (−3.1∼−1.1)
9th	10509	23.4 (22.0-24.7)	7186	17.6 (16.2-19.0)	−5.7 (−7.7∼−3.8)	3579	7.9 (7.1-8.8)	2289	5.5 (4.8-6.3)	−2.4 (−3.5∼−1.3)
Pocket money per week										
≤10 RMB	7046	13.4 (12.4-14.4)	4311	8.5 (7.7-9.3)	−4.9 (−6.2∼−3.6)	2029	3.9 (3.4-4.4)	945	2.0 (1.6-2.3)	−1.9 (−2.6∼−1.3)
11-30 RMB	8519	18.1 (16.9-19.3)	5756	13.6 (12.6-14.6)	−4.5 (−6.0∼−3.0)	2760	5.8 (5.2-6.4)	1685	4.0 (3.4-4.5)	−1.8 (−2.7∼−1.0)
≥31 RMB	9029	24.9 (23.2-26.6)	6384	19.1 (17.3-21.0)	−5.7 (−8.2∼−3.2)	3348	9.3 (8.4-10.3)	2322	6.9 (5.6-8.2)	−2.5 (−4.0∼−0.9)
Parents smoke										
Neither	7746	13.6 (12.7-14.5)	5471	8.9 (8.2-9.6)	−4.7 (−5.8∼−3.5)	2278	4.0 (3.6-4.4)	1435	2.2 (1.9-2.5)	−1.7 (−2.2∼−1.2)
Either	15317	20.7 (19.5-21.8)	10033	16.2 (15.0-17.3)	−4.5 (−6.2∼−2.9)	5157	7.0 (6.3-7.7)	3127	5.2 (4.4-5.9)	−1.8 (−2.8∼−0.8)
Both	1068	28.0 (25.5-30.4)	605	22.2 (19.6-24.8)	−5.7 (−9.3∼−2.1)	493	13.0 (11.2-14.8)	245	9.1 (7.2-11.0)	−3.9 (−6.5∼−1.3)
Friends smoke										
None	5755	6.1 (5.7-6.4)	4301	4.5 (4.2-4.8)	−1.6 (−2.0∼−1.1)	699	0.7 (0.6-0.7)	301	0.3 (0.2-0.3)	−0.4 (−0.5∼−0.3)
Some	18152	37.2 (35.8-38.5)	11645	32.2 (30.6-33.8)	−5.0 (−7.0∼−2.9)	6901	14.0 (13.0-15.0)	4257	11.7 (10.6-12.9)	−2.2 (−3.8∼−0.7)
All	679	65.0 (61.1-68.8)	517	61.6 (56.2-66.9)	−3.4 (−9.8∼3.0)	529	49.4 (45.5-53.2)	397	45.2 (40.2-50.2)	−4.1 (−10.3∼2.0)
High school students										
Total			30222	24.5 (23.3-25.7)				10298	8.6 (7.8-9.4)	
Academic high school students										
Total			20681	21.6 (20.4-22.8)				5654	5.6 (5.1-6.1)	
Sex										
Girls			5278	10.2 (9.4-11.0)				754	1.4 (1.1-1.6)	
Boys			15403	33.6 (31.9-35.2)				4900	10.0 (9.1-10.8)	
Residence										
Urban			10153	17.7 (16.4-19.0)				2784	4.1 (3.5-4.7)	
Rural			10528	23.9 (22.3-25.6)				2870	6.4 (5.7-7.1)	
Socioeconomic status*										
High (Eastern)			5318	17.0 (14.5-19.5)				1237	3.7 (2.9-4.5)	

Table 2 (Continued)

	Experimental use[a]					Current use[b]				
	2013–14		2019		Absolute change, % (95% CI)	2013–14		2019		Absolute change, % (95% CI)
	Unweighted, No	Weighted % (95% CI)	Unweighted, No	Weighted % (95% CI)		Unweighted, No	Weighted % (95% CI)	Unweighted, No	Weighted % (95% CI)	
Medium (Central)			7328	22.8 (21.3-24.4)				1763	5.2 (4.5-5.9)	
Low (Western)			8035	25.7 (23.8-27.6)				2654	8.1 (7.1-9.2)	
Grade										
10th			6360	20.0 (18.5-21.4)				1609	4.7 (4.1-5.3)	
11th			7097	21.7 (20.3-23.0)				2076	6.1 (5.4-6.8)	
12th			7224	23.3 (21.7-24.9)				1969	5.9 (5.2-6.7)	
Pocket money per week										
≤10 RMB			2653	17.7 (16.2-19.3)				625	4.0 (3.4-4.7)	
11-30 RMB			3759	19.0 (17.3-20.8)				899	4.4 (3.7-5.0)	
≥31 RMB			14238	23.6 (22.5-24.7)				4122	6.4 (5.9-7.0)	
Parents smoke										
Neither			7784	17.6 (16.5-18.7)				1893	4.0 (3.6-4.4)	
Either			11953	24.5 (23.2-25.8)				3359	6.6 (6.0-7.2)	
Both			625	35.7 (32.8-38.5)				267	14.0 (12.0-16.1)	
Friends smoke										
None			3563	7.3 (6.8-7.9)				163	0.2 (0.2-0.3)	
Some			16582	35.5 (34.2-36.7)				5089	10.4 (9.6-11.1)	
All			531	63.1 (58.1-68.2)				400	44.8 (39.2-50.4)	
Vocational high school students										
Total			9541	30.3 (27.7-32.9)				4644	14.7 (12.7-16.6)	
Sex										
Girls			2173	14.0 (12.4-15.6)				630	3.7 (2.9-4.4)	
Boys			7368	43.2 (40.1-46.3)				4014	23.3 (20.4-26.2)	
Residence										
Urban			4642	29.6 (25.4-33.8)				2247	14.5 (10.9-18.0)	
Rural			4899	30.9 (28.1-33.7)				2397	14.8 (12.9-16.7)	
Socioeconomic status*										
High (Eastern)			3100	26.8 (22.8-30.8)				1468	12.2 (9.3-15.1)	
Medium (Central)			3296	31.2 (26.7-35.6)				1418	13.0 (10.1-15.9)	
Low (Western)			3145	33.6 (29.1-38.1)				1758	19.2 (15.1-23.3)	
Grade										
10th			3483	30.8 (27.4-34.3)				1677	15.8 (13.0-18.5)	
11th			3546	30.2 (26.2-34.2)				1790	14.6 (11.9-17.2)	
12th			2512	29.7 (26.4-33.0)				1177	13.5 (10.7-16.3)	
Pocket money per week										
≤10 RMB			1092	25.8 (22.9-28.8)				461	10.2 (8.4-12.1)	
11-30 RMB			1784	26.9 (24.1-29.8)				829	12.5 (10.2-14.7)	

Table 2 *(Continued)*

	Experimental use[a]					Current use[b]				
	2013−14		2019		Absolute change, % (95% CI)	2013−14		2019		Absolute change, % (95% CI)
	Unweighted, No	Weighted % (95% CI)	Unweighted, No	Weighted % (95% CI)		Unweighted, No	Weighted % (95% CI)	Unweighted, No	Weighted % (95% CI)	
≥31 RMB			6653	32.4 (29.5-35.3)				3348	16.4 (14.1-18.8)	
Parents smoke										
Neither			3078	25.7 (23.3-28.1)				1320	10.7 (8.8-12.5)	
Either			5886	32.9 (29.8-36.0)				2989	17.0 (14.7-19.2)	
Both			391	45.0 (38.6-51.5)				227	25.4 (19.6-31.2)	
Friends smoke										
None			901	7.0 (6.1-8.0)				118	0.8 (0.5-1.1)	
Some			8154	41.8 (39.1-44.4)				4121	20.9 (18.5-23.2)	
All			484	77.3 (70.6-84.0)				404	65.4 (57.0-73.8)	

***Table 2*: Experimental use and current use of cigarette among middle and high school students for both genders in China, 2013-14 and 2019.**

[a] Experimental use was determined by asking "Have you ever tried or experimented with cigarette smoking, even one or two puffs?", and those whose answer was "Yes" were defined as experimental cigarette use.

[b] Current use was determined by asking "During the past 30 days, on how many days did you smoke cigarettes?", and the current use was defined as use on 1 or more days in the past 30 days.

Abbreviation: CI, confidence interval.

* Eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan. Central region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan. Western region includes Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia, Guangxi.

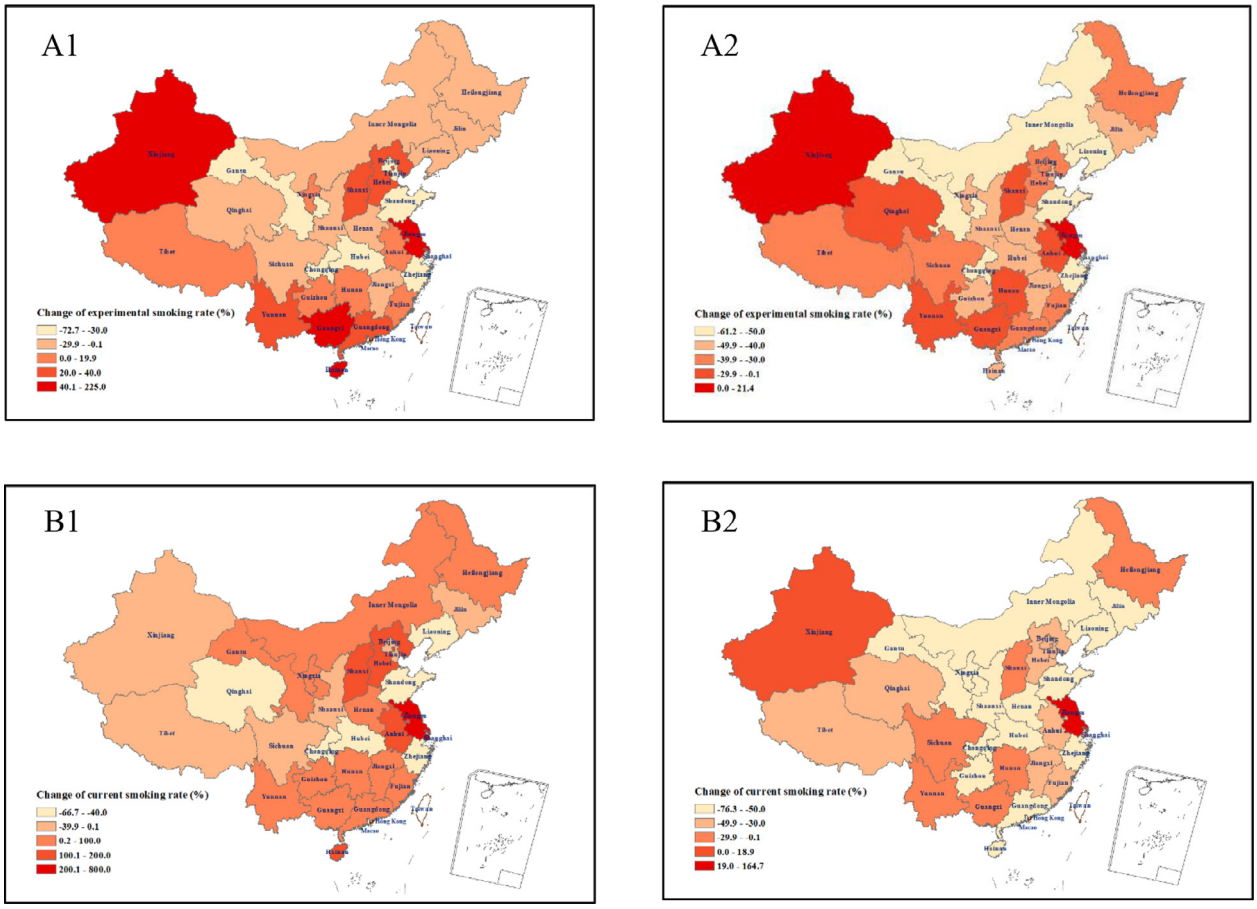

Figure 1. Provincial disparities in the change of experimental use and current use of cigarette among middle school students by sex in China, 2013-14 and 2019.

A: Provincial disparities in the change of experimental cigarette use.
A1: middle school girls A2: middle school boys.
B: Provincial disparities in the change of current cigarette use.
B1: middle school girls B2: middle school boys.

From 2013–14 to 2019, the rates of experimental and current cigarette use declined by 5.0% and 2.0% (percentage points) among middle school students, decreased by 9.9% and 4.1% for boys but increased by 0.2% and 0.2% among girls (Table 2). The increased prevalence of experimental and current cigarette uses among girls was mainly observed in rural areas with a 1.4% and 0.5% absolute increase, respectively (eTable 10). The rates of cigarette use among middle school students for girls increased in nearly half of 31 provinces, of which Hainan, Guangxi, Xinjiang, Anhui, Shanghai, Jiangsu, and Shanxi had large increases, while Jiangsu and Xinjiang only had increases among boys (Figure 1).

Frequency, intensity, and locations of cigarette use

In 2019, the prevalences of cigarette use on 20 or more days and daily cigarette use in the past 30 days were higher in vocational high school (5.9% and 4.1%) than in academic high school (1.8% and 1.2%) and middle school (0.7% and 0.5%) (Table 3), higher in higher grade and among boys (eFigure 3). The proportions of using more than 20 cigarettes per day in the past 30 days among current cigarette users were 3.7%, 3.7%, and 3.0%, respectively, for middle school, academic high school, and vocational high school, with no statistically significant difference, and higher in girls than boys among academic high school students (Table 3). The prevalences of frequent cigarette use (≥20 days in the past 30 days) and the proportions of heavy cigarette use (>20 cigarettes per day) were higher in the Southwest (Yunnan, Chongqing, Guizhou, Tibet), the North (Jilin, Shaanxi, Shandong), and the East (Shanghai, Zhejiang) (eFigure 4). Current cigarette users mainly smoked at school, home, and social venues. Among middle school and academic high school students, the

		Middle school students 2013–14	Academic high school students 2019	Vocational high school students		
				Absolute change, % (95% CI)	2019	2019
Smoking frequency (≥20 days and on all 30 days) in the past 30 days[a]						
Both	≥20 d	0.83 (0.71-0.95)	0.77 (0.61-0.93)	−0.06 (−0.26-0.14)	1.75 (1.56-1.94)	5.89 (4.75-7.02)
	Daily use	0.49 (0.41-0.57)	0.52 (0.41-0.63)	0.03 (−0.11-0.17)	1.16 (1.00-1.32)	4.11 (3.20-5.03)
Boys	≥20 d	1.43 (1.21-1.64)	1.28 (1.01-1.56)	−0.14 (−0.49-0.21)	3.29 (2.93-3.66)	9.90 (8.12-11.69)
	Daily use	0.84 (0.69-0.99)	0.86 (0.67-1.04)	0.02 (−0.22-0.26)	2.17 (1.85-2.48)	7.03 (5.59-8.48)
Girls	≥20 d	0.17 (0.13-0.22)	0.17 (0.12-0.23)	0.00 (−0.07-0.07)	0.26 (0.20-0.33)	0.78 (0.52-1.04)
	Daily use	0.10 (0.07-0.14)	0.13 (0.08-0.18)	0.03 (−0.03-0.09)	0.19 (0.14-0.25)	0.40 (0.24-0.57)
Smoking intensity (>20 cigarettes/day) in the past 30 days[b]						
Both		2.0 (1.6-2.3)	3.7 (2.6-4.8)	1.8 (0.6-3.0)	3.7 (3.0-4.5)	3.0 (1.9-4.1)
Boys		1.7 (1.3-2.1)	3.8 (2.7-5.0)	2.2 (1.0-3.4)	3.3 (2.6-4.1)	3.2 (2.0-4.4)
Girls		3.6 (1.8-5.4)	3.2 (1.4-5.0)	−0.4 (−0.6~-0.2)	6.5 (3.4-9.7)	1.3 (0.4-2.2)

***Table 3*: Smoking frequency and intensity of current cigarette users among middle and high school students by sex in China, 2013–14 and 2019.**

[a] The weighted proportion of students who has reported use more than 20 days and on all 30 days during the past 30 days. Smoking frequency was determined by asking "During the past 30 days, on how many days did you smoke cigarettes?". Those who reported use on all 30 days were defined as daily use.

[b] The weighted proportion of current cigarette smokers who has reported use more than 20 cigarettes per day by gender. Smoking intensity was determined by asking "Please think about the days you smoked cigarettes during the past 30 days. How many cigarettes did you usually smoke per day?".

proportion of smoking in internet cafes was higher in boys than girls but higher in girls than boys for the rate of smoking at social venues. Among vocational high school students, the proportion of smoking at home and school was higher in boys than girls (Figure 2). The proportions of smoking at school in Hunan, Yunnan, Guangxi, Jiangxi, Hubei, and Xinjiang were higher than in other provinces (eFigure 5).

From 2013–14 to 2019, among middle school students, the prevalence of frequent cigarette use (≥20 days in the past 30 days) dropped slightly with no statistical significance, but the proportions of heavy cigarette use (>20 cigarettes per day) have increased significantly, mainly among boys by 2.2% points (Table 3). The proportions of smoking in internet cafes and at friends' homes have decreased but increased at home, with no significant change at school (Figure 2).

Discussion

The prevalence rate of cigarette use among Chinese adolescents was significantly higher in boys than in girls and higher in rural areas than in urban areas, similar to the epidemiologic pattern of tobacco use among Chinese adults.[6] In 2019, the current cigarette use rate in China was 3.9% among middle school students, 1.8% for girls and 5.8% for boys, which is lower than the rates for 70% of WHO member states covered by the recent global survey of tobacco use.[20] About 8.6% of high school students reported currently using cigarettes in China, which is higher than the U.S. and Canada, and lower than Saudi Arabia and Ethiopia.[21–24] And the rate of current cigarette use in vocational high schools was 14.7%, much higher than that in middle schools and academic high schools. Rates of tobacco use among vocational high school students in European countries such as France and Denmark were also high, usually, 2–4 times that among academic high schools.[25,26]

As the surveys are nationally representative, we project that, among the national population of middle and high school students, an estimated 1.83 million middle school students and 3.09 million high school students currently smoke cigarettes in 2019 in China. From 2013–14 to 2019, the rate of current cigarette uses among middle school students dropped by 2.0 percentage points overall. The decline in cigarette use may be due to a series of tobacco control interventions, laws, and regulations implemented in China.[9,11–14] However, the decline in cigarette use is also accompanied by the increasing use of substitute products, of which the most common is e-cigarettes.[21] In fact, the rate of current e-cigarette use among middle school students rose by 125%, from 1.2% in 2013–14 to 2.7% in 2019,[27] but it is difficult to identify their causal effects in the present study.

An important finding in the study was the increase in smoking among rural girls in middle schools. With the economic development and female cigarette brand promotion in China, tobacco use has become more prevalent among women.[28,29] Tobacco use epidemic and easy access to tobacco in rural areas may have increased tobacco use among rural students.[30] With the migration of labor from rural to urban areas, left-behind children who lack parental company and supervision may be more likely to smoke, increasing the rate of tobacco use in rural areas. While the tobacco use epidemic among Chinese women is at its early stage, more girls or women will smoke without proper and timely

intervention.[31] Moreover, the smoking rate among middle school girls has increased in more than half of the provinces of mainland China, with the largest increase seen in Shanghai and Jiangsu, which are economically developed. In economically developed areas, women and girls are less like to be subject to traditional social norms.[30] Some of them may choose, unfortunately, to smoke to express themselves or to relieve stress. Regional economies relying on the tobacco industry may also promote smoking among adolescents, including girls. For instance, Yunnan, Guizhou, Henan, and Hunan, where cigarette smoking rates among girls are high, are important tobacco cultivating and manufacturing provinces.[32]

Heavy cigarette use (≥20 cigarettes/per day) among current users was more prevalent among female students, especially among academic high school girls. Besides, from 2013–14 to 2019, the rate of heavy use of cigarettes increased among male middle school students. This may be related to puberty and high academic pressure. Middle school students and academic high school students faced significant pressure to pass senior high school and college entrance exams, which contributed to the poor mental health among

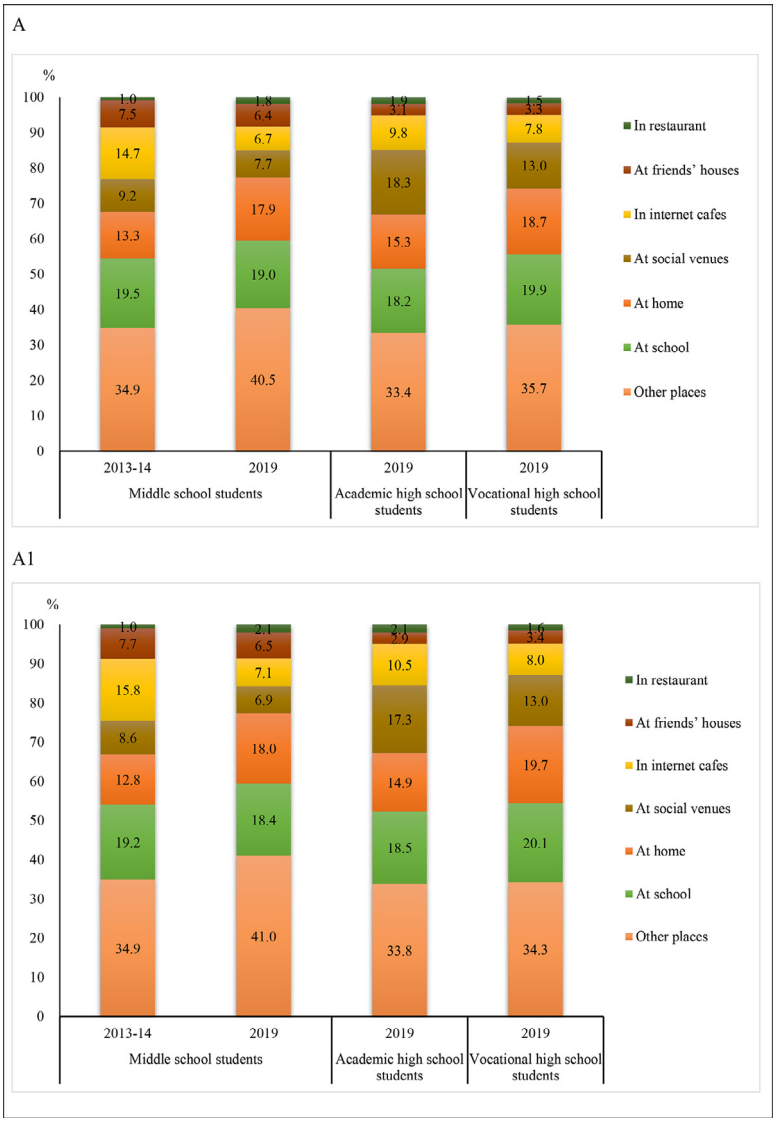

Figure 2. Location of smoking of current cigarette users among middle and high school students by sex in China, 2013-14 and 2019.
A: Smoking places of all students who currently use cigarettes.
A1: Smoking places of boys who currently use cigarettes.
A2: Smoking places of girls who currently use cigarettes.

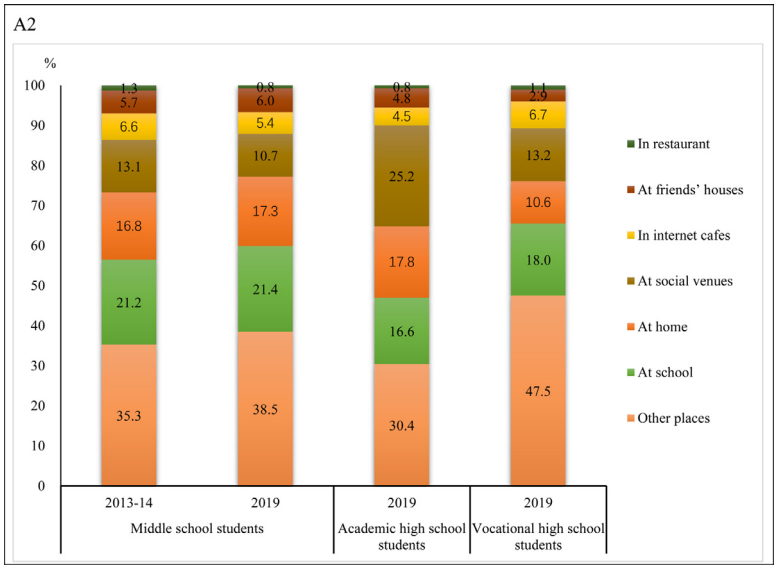

Figure 2. Continued

adolescents, especially among girls as girls are more vulnerable to pressure than boys.[33,34] Mental health conditions, such as depression and anxiety, may lead to heavy cigarette smoking and addiction.[34]

As the grade or age goes up, the rate of cigarette use and proportion of frequent smoking is gradually increasing, and the increase is more significant in boys than in girls. The prevalence of current cigarette use in boys increases from 5.8% among middle school students (mostly aged 11–14 years) to 14.8%, among high school students (mostly aged 15–18 years), with 10.0% for academic high school and 23.3% for vocational high school. The trend can be extrapolated to the older group with a higher rate. From the 2018 National Adult Tobacco Survey (NATS), the prevalence of current cigarette use among those aged 15–24 years is 33.7%.[6] However, the trajectory for girls differs. It increases from 1.8% to 2.0% (1.4% and 3.7% for academic and vocational schools, respectively), which is much higher than that among those aged 15–24 years in the 2018 NATS (0.9%).[6] Previous data from several adult surveys have demonstrated a continuous increase in the rate of cigarette use among women over age.[6,35,36] This unusual pattern indicates a need for more in-depth research and strengthened monitoring of tobacco use among girls and women.

For the first time, we conducted a national-level survey of tobacco use among high school students in 2019. The results indicate that the rates of any cigarette use and frequent use among vocational high school students were much higher than among academic high school and middle school students, without significant urban-rural, region, and grade disparities. Unlike academic high school students, vocational high school students have much less academic pressure but are more like to face bullying.[37] Students who experienced or witnessed bullying had a higher likelihood of cigarette smoking.[38] In addition, peer smoking increases the initiation and maintenance of smoking behaviors during adolescence.[39,40] The impact of family members' smoking, including parents and siblings, on youth smoking and nicotine addiction is also substantial.[41–43] In this study, cigarette smoking increased as more friends or parents smoked, especially for students in vocational high schools. We found that adolescents in China often smoked at school, at home, and at social venues where girls smoked more frequently. The use of tobacco as a tool of socializing in China may have contributed to the tobacco epidemic among adolescents.[44]

Furthermore, there were significant regional or socioeconomic gradients in cigarette use among Chinese adolescents. Smoking rates in the western region were higher than those in the central region, which were higher than those in the eastern region, similar to the epidemiologic characteristics of tobacco use among Chinese adults. This may be due to regional differences in socioeconomic status and tobacco control policies. The further to the east in China, the better the regiojal economic development. Better regional economic development is often associated with lower rates of tobacco use.[45–47] The higher prevalence and co-occurrence of risk factors of smoking initiation exist in lower socioeconomic status settings.[48] Adolescents in lower socioeconomic status environments are more susceptible to tobacco use initiation,[49,50] of those with more pocket money, however, are more likely to be smokers.[51] In this study, we found that the smoking rate has increased as pocket money grew. Besides, tobacco control policies are well implemented in cities with better economic

development.[52] Raising the price of tobacco products has the most potential to reduce inequalities resulting from the tobacco use epidemic.[53–55] Increasing the cost of cigarettes could reduce the rate of adolescent smoking initiation, especially for lower grades students.[51] In 2015, the Chinese government imposed an increase in tobacco excise tax, resulting in an average percentage of tax in the price of cigarettes at approximately 56%, and the first decrease in cigarette consumption in China since 2000 occurred, with the most decrease in the consumption of the cheapest cigarettes.[52] However, the proportion of tobacco excise tax is still far from 75% as advocated by the WHO.

Tobacco control should be strengthened to contain and control the tobacco use epidemic among Chinese adolescents. Tax and price increases and graphic warnings on cigarette packaging, often regarded as the most effective tobacco control measures, are urgently needed.[56] In addition to regular health education, educating young people on how to refuse smoking in socializing is equally important.

However, this study has two important limitations. First, as high school students were included in the national-level survey for the first time in 2019, changes in smoking patterns among high school students could not be ascertained. Second, through self-reported paper questionnaires to collect information, students' misunderstanding and inaccurate answers to questions may lead to recall biases. However, the large sample size of this study may minimize the impact of such biases.

From 2013–14 to 2019, the prevalence of experimental and current cigarette use in middle school students decreased significantly among both sexes but increased significantly among rural girls. Current cigarette use intensity rose among boys. Cigarette use among Chinese adolescents shows significant disparities across sexes and regions, with higher rates among boys, rural areas, and Western regions (low level of economic development). In 2019, current cigarette use was more prevalent among Chinese high school students, especially vocational high school students. Effective and targeted interventions for tobacco control among adolescents are in urgent demand in China.

Contributors

SwL and ZC designed the study and managed the project. XD, SxL, XZ, YZ, YN, XW, LX and SwL collected the data, collated the database and did the data analysis. XD and SwL had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. YZ and SwL drafted the manuscript. JK, ZC, SwL and LX offered administrative, technical and material support. The corresponding author had final responsibility for the decision to submit for publication. All authors reviewed and approved the final manuscript.

Data sharing statement

Individual participant data in our study will not be made available publicly. For further detailed data access policy and procedure, please contact chinatco@126.com.

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

ZC is supported by the National Natural Science Foundation (Grant#: 72174098). The rest of the authors declare no competing interests.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.lanwpc.2022.100549.

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