

## Preplanned Studies

## Characteristics and Associated Factors of E-cigarette Use Among Secondary School Students — 6 PLADs in China, 2021

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### Summary

#### What is already known about this topic?

Previous studies on electronic cigarette (e-cigarette) use in China among secondary school students have provided information on the awareness and usage of e-cigarettes.

#### What is added by this report?

This study not only described e-cigarette usage rates, but also explored the characteristics of e-cigarette users' behavior and factors associated with the current use of e-cigarettes among secondary school students.

#### What are the implications for public health practice?

E-cigarette use among secondary school students, especially among vocational senior high school students, requires more attention. Although some policies have been developed to protect youths from the harmful effects of e-cigarettes, enforcement of these policies needs to be strengthened.

The 2021 World Health Organization Report on the Global Tobacco Epidemic highlighted the addictive nature of e-cigarettes and called for regulation (*1*). China has implemented policies to protect youth from e-cigarettes, such as the revised Law of the People's Republic of China on the Protection of Minors banning the sale of electronic cigarettes to minors. This study was conducted based on the China National Youth Tobacco Survey (NYTS) framework with secondary school students [including junior high school (JHS) students, general senior high school (GSHS) students, and vocational senior high school (VSHS) students] in 2021, which was approved by the Institutional Review Board of China CDC (No. 202110). A total of 52,879 secondary school students from 6 provincial-level administrative divisions (PLADs) in China were asked about e-cigarette usage, purchase behaviors, and factors associated with the current e-cigarette usage to evaluate the previous policies and provide reference for next steps.

Using the results of the 2019 China NYTS (*2*), one

PLAD with a relatively high e-cigarette use rate and one PLAD with a relatively low e-cigarette use rate were selected in each of the central, eastern, and western regions of China. Consequently, Beijing Municipality; Guangdong, Hunan, Hubei, and Sichuan provinces; and Ningxia Hui Autonomous Region were selected. A 3-stage stratified cluster random sampling was employed in each PLAD. First, 5 districts (urban areas) and 5 counties (rural areas) were selected in each PLAD using a proportionate to population size sampling scheme (PPS). Second, 3 JHSs, 2 GSHSs, and 1 VSHS were selected using the PPS method within each selected district and county. Third, within selected schools, 1 class was randomly selected in each grade and all the students in the selected class were interviewed (if the class size was less than 30, the sample class was supplemented). Overall, 180 JHSs, 121 GSHSs, and 52 VSHSs from 60 districts/counties of the 6 PLADs participated in the survey from September to December 2021. A total of 52,879 eligible students (26,751 JHS students, 18,851 GSHS students, and 7,277 VSHS students) completed the questionnaire, of which 27,548 were male and 25,331 were female. The overall survey response rate was 95.2%.

In the interviews, structured paper-based questionnaires with no logical skips were used. Ever e-cigarette users (EES) were defined as students who had used e-cigarettes in the past; simply trying an e-cigarette one time qualified a student for this designation. Current e-cigarette users (CES) were students who had used e-cigarettes at least once in the past 30 days, and current smokers (CS) were students who had used cigarettes at least once in the past 30 days. All participants were asked if they had noticed advertisements for e-cigarettes or related products in the past 30 days and if they believed e-cigarette use is addictive. In addition, students were asked about their pocket money for a week and their parents' or close friends' smoking status. In terms of behaviors around e-cigarette use, all the CES were asked about e-cigarette flavors and the way of their purchase. Prevalence rates

and chi-square tests were calculated and reported in this study. A two-level mixed effect model was also constructed to analyze the associated factors of current e-cigarette use. As a potential factor associated with current e-cigarette use, the sale of e-cigarettes to minors was analyzed as a variable by dividing the number of all students who were not rejected when purchasing e-cigarettes due to age in each district/county into three groups: the highest quantile (Percentiles 75) was defined as more, the lowest quantile (Percentiles 25) was defined as less, and the middle fifty (Percentiles 75–Percentiles 25) was defined as general. SAS software (version 9.4, SAS Institute, Inc. Cary, NC, USA) was used to perform the analysis.

In 2021, the EES and CES prevalence rates among secondary school students in the six PLADs were 14.9% and 3.0%, respectively. For the EES prevalence rate, we found that males (20.4%) were more likely than females (8.8%) ( $P<0.001$ ) to have used an e-cigarette and that students in rural areas (17.0%) were more likely than students in urban areas (13.4%) ( $P<0.001$ ) to have used an e-cigarette. In addition, e-cigarette prevalence was found to be the highest among VSHS students (26.0%), followed by GSHS students (15.4%) and JHS students (11.4%) ( $P<0.001$ ). The highest EES prevalence rate was reported for Hunan (20.7%), while the lowest EES prevalence rate was in Guangdong (11.9%) ( $P<0.001$ ) (Table 1). For the CES prevalence rate, we found that males (4.3%) were more likely than females (1.6%) to have used e-cigarettes in the past 30 days ( $P<0.001$ ), that rural areas (3.4%) had a higher prevalence rate than urban areas (2.8%) ( $P<0.001$ ), and that VSHS students (7.0%) had the highest prevalence rate, followed by GSHS students (2.6%) and JHS students (2.2%) ( $P<0.001$ ). The highest CES prevalence rate was reported for Hunan (4.3%), while the lowest CES prevalence rate was in Guangdong (2.5%) and Hubei (2.4%) ( $P<0.001$ ) (Table 1).

Among CES, 58.3% had used e-cigarettes with fruit flavor and 9.3% had used e-cigarettes with tobacco flavor. Among all e-cigarette users, 52.9% also used combustible cigarettes. Students also bought e-cigarettes through the internet (36.3%), e-cigarette retail stores (27.4%), shops/supermarkets/grocery stores (14.5%), vending machines (3.2%), and at bars/KTVs (3.1%). When they bought e-cigarettes, 67.0% of them reported that they were not rejected because of their age. In addition, 28.0% of secondary school students reported they had seen advertisements for e-cigarettes or related products in the past 30 days.

The proportion of students who saw advertisements in e-cigarette retail stores, shops/supermarkets/grocery stores, on websites, social media, TV/broadcasts, billboards, and in newspapers/journals was 15.2%, 12.6%, 7.3%, 5.9%, 5.0%, 3.2%, and 1.8%, respectively.

Potential factors associated with current e-cigarette use among secondary school students were explored using a two-level mixed effect model. The model indicated that students were more likely to use e-cigarettes if they were current cigarette smokers [odds ratio (OR)=9.745, 95% confidence interval (CI): 8.183–11.605], noticed e-cigarette advertisements in the past 30 days (OR=3.518, 95% CI: 3.012–4.108), had weekly pocket money >40 CNY (OR=1.415, 95% CI: 1.143–1.751), and had at least one parent smoking (OR=1.280, 95% CI: 1.089–1.505). Compared to those who had no close friends that smoked, students where all close friends smoked (OR=18.178, 95% CI: 11.953–27.645), most close friends smoked (OR=14.476, 95% CI: 10.950–19.137), or some close friends smoked (OR=5.415, 95% CI: 4.385–6.686) were more likely to use e-cigarettes. In addition, secondary school students who believed e-cigarettes could be addictive were less likely to use e-cigarettes (OR=0.606, 95% CI: 0.496–0.740). Students in the highest quantile districts/counties of e-cigarette sales to minors were more likely to have used e-cigarettes than in the lowest quantile districts/counties (OR=1.871, 95% CI: 1.101–3.177) (Table 2).

## DISCUSSION

According to this study, 14.9% of secondary school students had used e-cigarettes and the current use rate was 3.0%. Males had a higher EES and CES prevalence rate than females. The prevalence rates of EES and CES among VSHS students were 26.0% and 7.0%, respectively. These were much higher than the rates observed among GSHS (15.4% and 2.6%) and JHS (11.4% and 2.2%) students. It was worth noting that the EES and CES prevalence rates among VSHS observed in 2019 NYTS were 20.5% and 4.5% respectively (2). Although the data from selected counties/districts in this study cannot be compared with the 2019 national-level data, the concern that e-cigarette use may be increasing among VSHS can be further studied.

Although there were some policies protecting youth from e-cigarette use that were enacted in 2018 and 2019, such as banning e-cigarette sales to minors,

TABLE 1. Ever and current e-cigarette use among secondary school students in six PLADs (2021).

Characteristics	Total		Ever e-cigarettes use		Current e-cigarettes use		
	N (%)	n (%)	$\chi^2$	P	n (%)	$\chi^2$	P
Overall	52,879 (100.0)	7,856 (14.9)			1,599 (3.0)		
Gender			1,409.07	<0.001		340.20	<0.001
Male	27,548 (52.1)	5,626 (20.4)			1,196 (4.3)		
Female	25,331 (47.9)	2,230 (8.8)			403 (1.6)		
Area type			133.84	<0.001		15.36	<0.001
Urban	31,504 (59.6)	4,216 (13.4)			877 (2.8)		
Rural	21,375 (40.4)	3,640 (17.0)			722 (3.4)		
School type			958.81	<0.001		462.91	<0.001
JHS	26,751 (50.6)	3,060 (11.4)			594 (2.2)		
GSHS	18,851 (35.6)	2,908 (15.4)			495 (2.6)		
VSHS	7,277 (13.8)	1,888 (26.0)			510 (7.0)		
PLAD			369.99	<0.001		76.94	<0.001
Beijing	7,956 (15.0)	1,009 (12.7)			250 (3.1)		
Guangdong	8,536 (16.2)	1,015 (11.9)			213 (2.5)		
Hunan	8,576 (16.3)	1,769 (20.7)			370 (4.3)		
Hubei	9,531 (18.0)	1,250 (13.1)			233 (2.4)		
Ningxia	8,693 (16.4)	1,463 (16.8)			286 (3.3)		
Sichuan	9,587 (18.1)	1,350 (14.1)			247 (2.6)		
Weekly pocket money			482.74	<0.001		215.51	<0.001
≤10 CNY	15,433 (29.3)	1,743 (11.3)			287 (1.9)		
11–40 CNY	17,846 (34.8)	2,353 (13.2)			416 (2.7)		
>40 CNY	19,443 (36.9)	3,730 (19.2)			893 (4.6)		
Current smoking			7,325.78	<0.001		9,574.44	<0.001
Yes	2,156 (4.1)	1,684 (78.2)			813 (37.8)		
No	52,517 (95.9)	5,944 (11.8)			724 (1.4)		
Parents smoking			405.69	<0.001		193.11	<0.001
None	23,941 (46.2)	2,709 (11.3)			444 (1.9)		
At least one	27,849 (53.8)	4,903 (17.6)			1,096 (4.0)		
Close friends smoking			8,170.63	<0.001		5,922.85	<0.001
None	36,908 (60.9)	2,574 (7.0)			223 (0.6)		
Some	14,166 (26.8)	4,030 (28.5)			822 (5.8)		
Most	1,425 (2.7)	987 (69.3)			425 (29.9)		
All	356 (0.6)	260 (73.0)			128 (36.0)		
Noticed e-cigarette advertisement			957.48	<0.001		1,077.32	<0.001
Yes	14,631 (28.0)	3,289 (22.5)			1,014 (6.9)		
No	37,623 (72.0)	4,434 (11.8)			554 (1.5)		
E-cigarette addictive cognition			2,656.18	<0.001		902.48	<0.001
Yes	14,774 (27.9)	1,473 (10.0)			281 (1.9)		
No	38,105 (72.1)	6,376 (16.7)			1,311 (3.4)		

Abbreviations: JHS= junior high school; GSHS= general senior high school; VSHS= vocational senior high school; PLAD= provincial-level administrative division; CNY= China Yuan.

TABLE 2. Factors associated with current e-cigarette use using a two-level mixed effect model.

Parameter	$\beta$	SE	t-value	P	OR (95% CI)
Fixed part					
Intercept	-7.286	0.303	-24.04	<0.001	
Gender					
Male	0.494	0.091	5.43	<0.001	1.639 (1.371–1.959)
Female					Ref
Area type					
Urban	-0.155	0.115	-1.35	0.178	0.857 (0.683–1.073)
Rural					Ref
School type					
JHS					Ref
GSHS	0.676	0.117	5.78	<0.001	1.669 (1.562–2.472)
VSHS	0.512	0.138	3.71	<0.001	1.965 (1.568–2.482)
PLAD					
Guangdong					Ref
Beijing	0.568	0.201	2.83	0.005	1.765 (1.189–2.619)
Hunan	0.585	0.177	3.30	0.001	1.796 (1.267–2.545)
Hubei	0.296	0.192	1.54	0.123	1.345 (0.922–1.962)
Ningxia	0.217	0.198	1.10	0.274	1.242 (0.842–1.832)
Sichuan	0.047	0.193	0.24	0.809	1.048 (0.716–1.533)
Weekly pocket money					
≤10 CNY					Ref
11–40 CNY	0.122	0.113	1.08	0.002	1.129 (0.905–1.408)
>40 CNY	0.347	0.109	3.19	0.001	1.415 (1.143–1.751)
Current smoking					
Yes	2.277	0.089	25.55	<0.001	9.745 (8.183–11.605)
No					Ref
Parents smoking					
None					Ref
At least one	0.247	0.083	2.99	0.003	1.280 (1.089–1.505)
Close friends smoking					
None					Ref
Some	1.689	0.108	15.70	<0.001	5.415 (4.385–6.686)
Most	2.673	0.142	18.76	<0.001	14.476 (10.950–19.137)
All	2.900	0.214	13.56	<0.001	18.178 (11.953–27.645)
Noticed e-cigarette advertisement					
Yes	1.258	0.079	15.89	<0.001	3.518 (3.012–4.108)
No					Ref
E-cigarette addictive cognition					
Yes	-0.501	0.102	-4.92	<0.001	0.606 (0.496–0.740)
No					Ref
E-cigarette sales to minors					
More	0.626	0.270	2.32	0.021	1.871 (1.101–3.177)
General	0.479	0.215	2.23	0.027	1.615 (1.058–2.465)
Less					Ref
Random part					
2 horizontal variances	0.288	0.058	4.97	<0.001	

Abbreviations: SE=standard error; OR=odds ratio; CI=confidence interval; JHS=junior high school; GSHS=general senior high school; VSHS=vocational senior high school; PLAD=provincial-level administrative division; CNY=China Yuan.

prohibiting selling e-cigarettes on the internet, and banning advertisements of e-cigarettes on the internet (3–4), 67.0% of current e-cigarette users reported they were not rejected when they bought e-cigarettes in the past 30 days. In fact, 36.3% of current e-cigarette users bought e-cigarettes through the internet. This suggests that relevant e-cigarette policies were not well enforced.

Like other studies (5–6), the vast majority (58.3%) of e-cigarette users among secondary school students in this study used fruit-flavored e-cigarettes. Previous studies showed that flavors might attract youths to try e-cigarettes (7). On May 1, 2022, the Management Regulation of Electronic Cigarettes prohibited flavors except for tobacco flavor. The effect of this policy in reducing the attraction of e-cigarettes among adolescents should be examined in future studies.

Among CES, 52.9% smoked combustible cigarettes, which is much lower than the reported rate in adult populations (90.6%) (8). Additionally, our study found that the probability of currently smoking students who use e-cigarettes was 9.745 times that of non-smoking students, which indicates current smokers are more likely to use e-cigarettes. Our study also found that a smoking parent or friend increases the risk for secondary school students to use e-cigarettes. This is consistent with findings from previous studies (9–10).

In our study, a two-level mixed effect model revealed that “noticed e-cigarette advertisement” was associated with e-cigarette use (OR=3.518). Overall, 28.0% of secondary school students reported they had seen advertisements for e-cigarettes or related products in the past 30 days. This finding highlights the importance of prohibiting e-cigarette advertisements, especially near schools. Our study also found students who believed e-cigarettes could be addictive were less likely to use e-cigarettes (OR=0.606). This suggests that introducing e-cigarette information into health education could reduce e-cigarette use.

A potential limitation of this study is that the survey data was collected using a self-reported questionnaire, which may have led to an underreporting and recall bias. In addition, this study only uses quantitative research methods. Therefore, there is a lack of in-depth research and discussion on the reasons why secondary school students use e-cigarettes and their attitudes on using e-cigarettes.

In conclusion, e-cigarette use among secondary school students, especially among vocational senior

high school students, requires more attention. Although there have been some policies enacted to protect youth from e-cigarettes, enforcement of these policies needs to be strengthened. Factors associated with e-cigarette use should be considered to guide new policies, such as health education and banning e-cigarette advertisements.

**Conflicts of interest:** No conflicts of interest.

**Acknowledgements:** All the colleagues from local institutions in the data collection. Yin Xi from WHO WPRO Office.

doi: 10.46234/ccdcw2022.126

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Submitted: June 14, 2022; Accepted: June 28, 2022

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