

Preplanned Studies

Prevalence and Determinants of Secondhand Smoke Exposure Among Adolescent Girls — China, 2019

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Summary

What is already known about this topic?

The rate of secondhand smoke (SHS) exposure among female junior high students in 2013–2014 in China was 69.9%.

What is added by this report?

The rate of SHS among adolescent girls in 2019 in China was 62.8%, with 60.8% in junior high and 65.3% in senior high school, meanwhile, higher SHS exposure was correlated to higher grade levels, senior high school over junior high school, urban areas, those with more pocket money, those who've attempted smoking, exposure to tobacco advertisements, those with parents who smoke, those with close friends who smoke, use of e-cigarettes, and belief that SHS exposure is detrimental to health.

What are the implications for public health practice?

The rate of SHS exposure among adolescent girls in China still remains extraordinarily high. Targeted public health initiatives to curb SHS exposure among adolescent girls are urgently needed in China.

Secondhand smoke (SHS) exposure is harmful to health: there is no risk-free level, and it negatively influences smoking behaviors as well (1–2). Girls are particularly vulnerable to the adverse health outcomes associated with SHS; a recent study indicated exposure to SHS increases the risk of developing breast cancer, especially when the exposure occurs in puberty when breast cell proliferation is most rapid (3). The prevalence of SHS exposure in China (69.9%) in 2013–2014 was much higher than that in 68 other low-income and middle-income countries (54.1%) in 2006–2013 for girls aged 12–15 (4). However, the prevalence of SHS exposure at the present is unknown, and the research on its determinants among adolescent girls is limited in China. This study aims to describe the status quo of SHS exposure and explore its determinants among adolescent girls.

The data for this study were extracted from the 2019

China National Youth Tobacco Survey (NYTS), in which a multi-stage, stratified, cluster random sampling design was used to acquire a nationally representative sample. First, 347 districts or counties were selected with a probability proportional to the population size sampling (PPS) method from 31 provincial-level administrative divisions (PLADs) in China. Second, 3 junior high schools and 3 senior high schools (2 academic and 1 vocational) were selected using PPS in each sampled district or county. Third, a class was selected randomly in every grade of each sampled school. All students of the selected class were invited to complete paper-based questionnaires distributed by well-trained investigators independently without the presence of teachers. A total of 154,287 junior high and 149,764 senior high school students were included, with the overall response rates being 95.5% and 94.1%, respectively. The average median age of students surveyed was 15 years old.

In the 2019 China NYTS, all the participants were asked: 1) In the past 7 days, how many days did someone smoke in your home in your presence? 2) In the past 7 days, how many days did someone smoke in any indoor public places in your presence, such as teaching buildings, indoor venues, gymnasiums, internet cafes, stores, restaurants, shopping malls, or cinemas? 3) During the past 7 days, how many days did someone smoke in any outdoor public places in your presence, such as playgrounds, sidewalks, stations, building entrances, or parks? and 4) How many days did someone smoke in your presence in public transportation such as trains, buses, or taxis over the past 7 days? Being exposed to SHS at any place (i.e., at home, in indoor public places, in outdoor public places, or on public transportation) on ≥ 1 days in the past 7 days was defined as SHS exposure.

All parameter estimations were weighted based on a complex sampling design. Multilevel modeling of complex survey data was used to explore determinants of SHS exposure, with individuals being level-1 units and schools being level-2 clusters. Point values with 95% confidence intervals (CI) were presented for each

parameter, and the difference with no overlap in CIs was identified to be statistically significant between subgroups. All analyses were conducted by SAS software (version 9.4, SAS Institute Inc., Cary, USA).

In this study, 70,778 and 72,169 female students in junior high and senior high schools, respectively, accomplished the questionnaire, of which 62.8% (61.5, 64.1) on average overall [60.8% (59.3, 62.1) from junior high and 65.3% (63.7, 67.0) from senior high school] were exposed to SHS in any place — with 31.7% (30.6, 32.8) at home, 46.5% (45.4, 47.6) in indoor public places, 48.8% (47.5, 50.0) in outdoor public places, and 22.1% (21.1, 23.1) on public transportation. The prevalence of SHS exposure in indoor public and outdoor public places was significantly higher than that at home and in public transportation — despite smoking or not and across different types of schools. In terms of geographic location, be it at home or in public places, there was no significant difference observed in the rate of SHS exposure between urban and rural areas. However, more girls in rural areas were exposed to SHS in public transportation than those in urban areas. For female non-smokers, the SHS exposure rate of senior high school students [64.8% (63.1, 66.4)] was higher than that of junior high school students [60.2% (58.8, 61.6)], but no significant difference between schools in SHS exposure was observed for female smokers [91.6% (88.2, 95.0) *vs.* 91.7% (89.1, 94.3)]. (Table 1)

The null model in multilevel modeling showed a statistically significant random part of level-2 accounting for 12 percent of the total variance ($P < 0.0001$) and indicated the hierarchical structure of the data in this study. As a result, the introduction of Multilevel modeling was needed.

The results of the Multilevel modeling showed that higher grade levels [grade one as reference, grade two: odds ratio (OR)=1.438; grade three: OR=1.456], senior high school status (junior high school as reference: OR=1.158), urban areas (rural as reference: OR=1.302), more pocket money (OR=1.334), current smoking behaviors (no as reference: OR=2.441), exposure to tobacco advertisements (none as reference, one venue: OR=2.047; two venues: OR=2.222; three venues: OR=3.639), parental smoking behaviors (no one as reference: OR=2.098), close friends' smoking behaviors (no one as reference: OR=1.950), use of e-cigarettes (no as reference: OR=1.654), and believing SHS exposure is detrimental to health (no as reference, maybe not: OR=1.504; maybe yes: OR=1.952; certainly: OR=2.430) were factors associated with

higher SHS exposure (Table 2).

DISCUSSION

The prevalence of SHS exposure among Chinese adolescent girls (62.8%) in 2019 was similar to that among those aged 12 to 16 globally (62.9%) in 2010–2018 (5). The percentage of SHS exposure at home in China (32.0%) in 2019 was lower than that in Malaysia in 2016 (38.1%) but higher than that in the U.S. (25.3%) in 2019 (6–7).

In any place, be it at home (32.0%), indoor public places (43.4%), outdoor public places (46.3%), or public transportation (20.5%), the rate of SHS exposure among girls in junior high school in 2019 was markedly lower than that from 2013–2014 (42.1%, 53.9%, 55.3%, and 34.5%) (8). The fastest decline was observed for public transportation while the slowest was observed for outdoor public places. Both in 2013–2014 and 2019, the rates of SHS exposure in public places were critically higher than rates at home, which is consistent with the results of other research (5). These findings not only highlight the improvement of tobacco control regulation but also showcase the importance of enhanced implementation of smoke-free public places and homes in conjunction with continuous efforts to implement tobacco control regulation in public transportation (9).

Despite the fact that tobacco use among adolescent girls is very low in China, more than half of non-smokers (62.2%) were affected by tobacco use. Moreover, non-smokers exposed to SHS at home and in other places were 1.4–2.1 and 1.3–1.8 times more likely to be vulnerable to initiating smoking than those not exposed, respectively (1). From January 2006, when the World Health Organization's Framework Convention on Tobacco Control (FCTC) came into force in China, to August 2019, 22 cities implemented local or government regulations for tobacco control (9). However, the people protected by these laws only account for 15% of the total population of the country. In order to protect more people from tobacco use, regulations need to be introduced in more cities as soon as possible (9).

According to the results of the Multilevel modeling, use of electronic cigarettes (e-cigarettes) was associated with secondhand smoke exposure. In other words, this study found that adolescent girls with experience using e-cigarettes were more susceptible to SHS.

Among females, the odds of being exposed to SHS were higher among those with one or both parents

TABLE 1. Secondhand smoke exposure among adolescent girls in China, 2019.

Types of school	Region	Places of exposure, % (95% CI)				
		Home	Indoor public places	Outdoor public places	Public transport	Any place
Both						
Overall	Total	31.7 (30.6, 32.8)	46.5 (45.4, 47.6)	48.8 (47.5, 50.0)	22.1 (21.1, 23.1)	62.8 (61.5, 64.1)
	Urban	31.5 (29.9, 33.2)	45.8 (44.1, 47.5)	49.5 (47.3, 51.7)	19.5 (18.2, 20.7)	63.3 (61.1, 65.5)
	Rural	31.8 (30.3, 33.2)	46.8 (45.3, 48.3)	48.2 (46.7, 49.8)	23.9 (22.5, 25.4)	62.4 (61.0, 64.0)
Junior high school	Total	32.0 (30.9, 33.1)	43.4 (42.2, 44.6)	46.3 (45.0, 47.7)	20.5 (19.3, 21.6)	60.8 (59.3, 62.1)
	Urban	31.6 (30.2, 33.0)	43.4 (41.8, 45.0)	48.2 (46.0, 50.4)	18.5 (17.2, 19.8)	62.0 (60.0, 64.0)
	Rural	32.2 (30.6, 33.8)	43.5 (41.8, 45.1)	45.2 (43.6, 47.0)	21.7 (20.1, 23.4)	60.1 (58.2, 62.0)
Senior high school	Total	31.3 (29.8, 32.7)	50.2 (48.6, 51.8)	51.7 (50.1, 53.3)	24.0 (22.7, 25.4)	65.3 (63.7, 67.0)
	Urban	31.5 (29.1, 33.9)	48.5 (46.1, 51.0)	50.9 (48.2, 53.7)	20.5 (18.8, 22.2)	64.9 (62.0, 67.7)
	Rural	31.1 (29.4, 32.9)	51.3 (49.2, 53.4)	52.2 (50.2, 54.1)	26.8 (24.9, 28.7)	65.6 (63.7, 67.5)
Non-smoker						
Overall	Total	31.1 (30.0, 32.2)	45.8 (44.7, 47.0)	48.1 (47.0, 49.4)	21.6 (20.6, 22.6)	62.2 (61.0, 63.5)
	Urban	31.1 (29.4, 32.8)	45.3 (43.6, 47.0)	49.0 (46.8, 51.2)	19.1 (17.9, 20.3)	62.9 (60.7, 65.0)
	Rural	31.1 (29.7, 32.5)	46.1 (44.6, 47.6)	47.6 (46.1, 49.1)	23.4 (22.0, 24.8)	61.8 (60.3, 63.3)
Junior high school	Total	31.4 (30.3, 32.5)	42.8 (41.6, 43.9)	45.8(44.5, 47.1)	20.0 (18.9, 21.1)	60.2 (58.8, 61.6)
	Urban	31.2 (29.9, 32.6)	43.0 (41.3, 44.6)	47.8 (45.6, 50.0)	18.2 (16.9, 19.5)	61.6 (59.5, 63.6)
	Rural	31.5 (29.9, 33.1)	42.7 (41.1, 44.3)	44.6 (43.0, 46.3)	21.2 (19.6, 22.7)	59.4 (57.5, 61.2)
Senior high school	Total	30.7 (29.3, 32.1)	49.6 (48.0, 51.2)	51.1 (49.5, 52.7)	23.6 (22.2, 24.9)	64.8 (63.1, 66.4)
	Urban	31.0 (28.6, 33.4)	47.9 (45.5, 50.3)	50.3 (47.6, 53.1)	20.1 (18.4, 21.8)	64.3 (61.4, 67.2)
	Rural	30.5 (28.7, 32.3)	50.7 (48.6, 52.8)	51.6 (49.6, 53.5)	26.3 (24.4, 28.2)	65.1 (63.2, 67.0)
Smoker						
Overall	Total	61.8 (58.7, 64.9)	79.8 (76.4, 83.3)	78.5 (75.5, 81.4)	42.1 (38.7, 45.5)	91.6 (89.5, 93.8)
	Urban	56.4 (51.4, 61.5)	77.8 (73.4, 82.2)	79.5 (75.2, 83.8)	38.0 (34.0, 42.1)	91.2 (87.4, 95.0)
	Rural	64.4 (60.5, 68.3)	80.8 (76.2, 85.5)	78.0 (74.1, 81.8)	44.3 (39.5, 49.2)	91.9 (89.3, 94.5)
Junior high school	Total	64.4 (60.3, 68.5)	80.2 (75.5, 84.8)	77.1 (72.5, 81.7)	42.8 (37.3, 48.3)	91.7 (89.1, 94.3)
	Urban	61.4 (54.8, 68.0)	80.9 (77.2, 84.6)	82.2 (78.2, 86.1)	41.4 (34.5, 48.3)	92.8 (89.8, 95.8)
	Rural	65.3 (60.2, 70.3)	79.9 (74.0, 85.9)	75.5 (69.6, 81.5)	43.3 (36.1, 50.5)	91.4 (88.1, 94.6)
Senior high school	Total	59.0 (54.3, 63.7)	79.5 (75.3, 83.7)	80.0 (76.5, 83.4)	41.4 (37.4, 45.4)	91.6 (88.2, 95.0)
	Urban	53.5 (46.5, 60.5)	76.0 (69.7, 82.3)	78.0 (72.2, 83.8)	36.0 (30.5, 41.4)	90.2 (84.5, 96.0)
	Rural	63.1 (56.6, 69.6)	82.2 (76.5, 87.8)	81.5 (77.3, 85.7)	45.6 (39.5, 51.7)	92.6 (88.4, 96.8)

Abbreviation: CI=confidence interval.

smoking. This finding was also discovered in several other studies, one of which reported that parents were responsible for 90% of children's SHS exposure (10–11). Therefore, educating parents about the hazard of SHS and enforcing complete smoking bans at home is critical to keeping adolescents away from SHS (3). As demonstrated in another study, adolescent girls whose intimate friends were smokers had an increased likelihood of being exposed to SHS. Hence, parents should also be involved in the lives of adolescents and keep an eye on their close friends (10).

Exposure to tobacco advertisements increased the possibility of being exposed to SHS, suggesting that comprehensive bans on tobacco advertisements, sponsorships, and marketing were also effective in avoiding exposure to SHS in China (12). Girls who believed in the harm of SHS had significantly more SHS exposure than those who did not, which may be due to better health consciousness or higher sensitivity to secondhand smoke (13).

Limitations exist in this study. First, SHS exposure was collected by self-reporting rather than identified by

TABLE 2. Multilevel modeling for secondhand smoke exposure among adolescent girls.

Parameter	Estimate (95% CI)	SE	t	P	OR (95% CI)
Fixed effects					
Intercept	-1.952 (-2.339, -1.565)	0.198	-9.880	<0.001	
School types					
Junior high school					1.0
Senior high school	0.147 (0.035, 0.259)	0.057	2.570	0.010	1.158 (1.035, 1.295)
Grade					
One					1.0
Two	0.364 (0.214, 0.513)	0.076	4.760	<0.001	1.438 (1.238, 1.671)
Three	0.376 (0.256, 0.495)	0.061	6.150	<0.001	1.456 (1.292, 1.641)
Regions					
Rural					1.0
Urban	0.264 (0.141, 0.387)	0.063	4.220	<0.001	1.302 (1.152, 1.472)
Pocket money					
No					1.0
Yes	0.288 (0.139, 0.438)	0.076	3.770	0.001	1.334 (1.149, 1.550)
Smoking					
No					1.0
Yes	0.893 (0.138, 1.647)	0.385	2.320	0.021	2.441 (1.148, 5.193)
Others' smoking does harm to you					
No					1.0
Maybe not	0.408 (-0.059, 0.876)	0.239	1.710	0.087	1.504 (0.942, 2.402)
Maybe yes	0.669 (0.328, 1.009)	0.174	3.850	0.001	1.952 (1.389, 2.743)
Certainly	0.888 (0.541, 1.234)	0.177	5.020	<0.001	2.430 (1.718, 3.436)
Exposure to tobacco advertisement					
None					1.0
One venue	0.717 (0.611, 0.822)	0.054	13.350	<0.001	2.047 (1.843, 2.274)
Two venues	0.798 (0.648, 0.949)	0.077	10.390	<0.001	2.222 (1.911, 2.583)
Three venues	1.292 (1.057, 1.527)	0.120	10.780	<0.001	3.639 (2.877, 4.603)
Tobacco use of parents					
No one					1.0
At least one	0.741 (0.637, 0.845)	0.053	13.990	<0.001	2.098 (1.891, 2.328)
Tobacco use of close friends					
No one					1.0
At least one	0.668 (0.537, 0.799)	0.067	9.970	<0.001	1.950 (1.711, 2.224)
Use of e-cigarette					
No					1.0
Yes	0.503 (0.288, 0.718)	0.110	4.590	<0.01	1.654 (1.334, 2.050)
Random effects					
Level 2 $\sigma^2_{u_0}$	0.577	0.060	9.652	<0.001	

Abbreviation: CI=confidence interval; SE=standard error; OR=odd ratio; $\sigma^2_{u_0}$ =random coefficient.

biomarkers such as serum cotinine, which might lead to misreporting or recall bias. However, self-reported SHS exposure is widely adopted across similar epidemiological studies: making these results comparable to other research (3,10). Second, this study cannot analyze the changes in SHS exposure among senior high school students over time, as this was investigated for the first time in 2019.

In conclusion, SHS exposure among adolescent girls in China is still an important public health issue. In order to better curb SHS exposure, targeted public health initiatives need to be strengthened in China.

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