

Prevalence and Determinants of Secondhand Smoke Exposure Among Middle and High School Students

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abstract

BACKGROUND: Secondhand smoke (SHS) causes disease and death among nonsmokers. Private settings are major sources of exposure for children. We assessed prevalence and determinants of self-reported SHS exposure in homes and vehicles, as well as school, work, and indoor/outdoor public areas, among US students in grades 6 through 12.

METHODS: Data were from the 2013 National Youth Tobacco Survey ($n = 18\,406$). Self-reported SHS exposure within the past 7 days was assessed overall and by extent of smoke-free home and vehicle rules among never users of 10 tobacco product types. Descriptive statistics were used to compare estimates, and adjusted prevalence ratios were calculated to assess determinants of SHS exposure.

RESULTS: Among never tobacco users, 48.0% reported SHS exposure in 1 or more locations, including 15.5% in the home, 14.7% in a vehicle, 16.8% at school, 27.1% at work, and 35.2% in an indoor/outdoor public area. Home exposure was 8.5%, 55.3%, and 79.4% among never tobacco users with complete, partial, or no smoke-free home rules, respectively ($P < .05$). Vehicle exposure was 7.1%, 44.8%, and 70.2% among never tobacco users with complete, partial, or no smoke-free vehicle rules, respectively ($P < .05$). Factors associated with higher prevalence ratio of SHS exposure included current tobacco use, truant behavior, and having tobacco using household members/friends

CONCLUSIONS: Approximately half of US students in grades 6 through 12 reported exposure to SHS in 2013. Smoke-free home and vehicle rules, coupled with intensified implementation and enforcement of comprehensive smoke-free laws, could help protect youth from this preventable health hazard.

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WHAT'S KNOWN ON THIS SUBJECT: Secondhand smoke exposure causes disease and death in nonsmokers. Despite progress in implementing comprehensive smoke-free laws prohibiting smoking in public settings, millions of US adults and children remain exposed to secondhand smoke in private settings.

WHAT THIS STUDY ADDS: Among US students who never used tobacco, 48.0% reported secondhand smoke exposure. Home or vehicle exposure was more than ninefold higher among never tobacco users with no home or vehicle smoke-free rules than those with 100% smoke-free rules.

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Secondhand smoke (SHS) exposure causes several adverse health conditions in children, including middle ear disease, respiratory symptoms, impaired lung function, lower respiratory illness, and sudden infant death syndrome.^{1,2} Over the past decade, major strides have been made within the United States in protecting nonsmokers from involuntary SHS exposure. As of January 2015, 26 US states and the District of Columbia had implemented comprehensive smoke-free laws prohibiting smoking in all indoor public places and worksites, including restaurants and bars.³ Additionally, ~700 local communities have implemented such laws; ~50% of the US population is currently covered by a state and/or local comprehensive smoke-free law.⁴ These laws have benefitted public health as indicated by corresponding declines in SHS exposure in children and adults and by the increased adoption of voluntary smoke-free home and car rules in US households.⁵⁻⁷ Of US households nationally, the proportion with smoke-free home rules almost doubled between 1992–1993 (43%) and 2010–2011 (83%), and 73.6% reported having a smoke-free vehicle rule during 2009–2010.^{6,7}

Despite these noted advances, several states have no statewide law addressing SHS in public areas, and others have enacted laws with less stringent smoking restrictions.⁴ Moreover, private settings largely not covered by these laws, such as homes and vehicles, remain major sources of SHS exposure among children.¹ Approximately 29% of US parents who live with their children are current cigarette smokers, and 44% of US adult smokers report smoking in a car when nonsmokers are present^{8,9}; accordingly, children with smoking parents may be exposed to high levels of SHS in these settings over prolonged periods. Students may also be susceptible to SHS

exposure on school grounds because only 67.5% of US public school districts had complete tobacco-free environments during 2012.¹⁰

Earlier studies have examined SHS exposure in select environments, such as vehicles and at school, among national samples of US middle and high school students.¹¹⁻¹³ However, limited recent data exist on SHS exposure among nonsmoking US middle and high school students across a diverse range of environments. It is a public health priority to protect children from SHS exposure in all settings, especially given that children who have never smoked tobacco products may still be exposed to SHS in a variety of both private and public settings. This study assessed the prevalence and determinants of self-reported SHS exposure at home, in a vehicle, at school, at work, and in indoor/outdoor public areas among a nationally representative sample of US students in grades 6 through 12 during 2013.

METHODS

Data Source/Sample

Data were from the 2013 National Youth Tobacco Survey (NYTS), an ongoing school-based survey that collects information on key tobacco-related measures from middle school (grades 6–8) and high school (grades 9–12) students.¹⁴ Students completed a self-administered, pencil and paper questionnaire in a classroom setting.

The NYTS uses a 3-stage cluster sampling procedure to generate cross-sectional, nationally representative samples of US middle and high school students. The sampling frame consists of all public and private school students enrolled in grades 6 through 12 in the 50 states and the District of Columbia.

Sampling procedures for NYTS are probabilistic and conducted without replacement at 3 stages: (1) primary

sampling unit, such as a county, group of small counties, or portion of a large county; (2) schools within each selected primary sampling unit; and (3) classes within each selected school. During 2013, 18 406 students completed the questionnaire, yielding an overall response rate of 67.8%.¹⁴

Measures

Tobacco Use

Never tobacco users were students who reported never using any of the following tobacco products in their lifetime: cigarettes/flavored cigarettes, roll-your-own tobacco, cigars/flavored cigars, pipes, bidis, kreteks, hookahs, electronic cigarettes (e-cigarettes), smokeless tobacco (dissolvable tobacco, chewing tobacco/snuff/dip, or snus), or “some other new tobacco products not listed.” Former tobacco users were students who had ever used any tobacco products during their lifetime but did not use any tobacco products within the past 30 days. Current tobacco users were students who had used any tobacco products on at least one day during the past 30 days. Exclusive current use was assessed for certain tobacco products (cigarettes, smokeless tobacco products, and electronic cigarettes), and was defined as use of the specified product within the past 30 days, but no other tobacco product.

Self-Reported Exposure to Secondhand Smoke

Self-reported exposure to SHS at home and in a vehicle were assessed with the following respective questions: “During the past 7 days, on how many days did someone smoke tobacco products in your home while you were there?” “During the past 7 days, on how many days did you ride in a vehicle where someone was smoking a tobacco product?” Self-reported exposure in the other environments was assessed with separate questions with the following common stem: “During

the past 7 days, on how many days did you breathe the smoke from someone who was smoking a tobacco product?" The environments assessed were "at school, including school buildings, school grounds, and school parking lots?"; "in the place where you work?" and "in an indoor or outdoor public place?"

Among all respondents, students were classified as being exposed to SHS in the specified environment if they reported exposure on at least 1 day within the past 7 days. Any SHS exposure was defined as self-reported exposure on at least 1 day within the past 7 days, in at least 1 of the 5 environments assessed. Among those exposed, we further classified the frequency of exposure as daily (all 7 days) or nondaily (1–6 days). For the question assessing SHS exposure at work, students who indicated "I do not have a job" or "I did not work during the past 7 days" were excluded from analyses for this indicator.

Smoke-Free Rule Presence and Compliance

Smoke-free home rules were assessed with the question, "Inside your home (not counting decks, garages, or porches) is smoking (1) Always allowed" [no smoke-free rules]; (2) Allowed only at some times or in some places" [partial smoke-free rules], or (3) "Never allowed" [complete smoke-free rules]. Smoke-free vehicle rules were assessed with the question "In the vehicles that you and family members who live with you own or lease, is smoking . . ." with the same response options and definitions. Compliance with smoke-free school policies was assessed with the following 2 questions: "During the past 30 days, to your knowledge, has anyone, including yourself, smoked a tobacco product on school property when he or she was not supposed to?"; and "During the past 30 days, to your knowledge, has

anyone, including yourself, used some other type of tobacco product (that is, one that is not smoked) on school property when he or she was not supposed to?" A response of "Yes" to either question was taken as an indication of partial or no compliance with smoke-free school policies, while a response of "No" to both questions indicated complete compliance with smoke-free school policies.

Covariates

Sociodemographic characteristics included gender (boy or girl); race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic other, or Hispanic); school level (middle [grades 6–8] or high [grades 9–12]); tobacco use by household members (yes or no); tobacco use by close friends (yes or no); and past-year truant behavior (a report of having "skipped" or "cut" class for ≥ 1 class period within the past 12 months; yes or no).

Analysis

Prevalence of self-reported SHS exposure was calculated overall and stratified by sociodemographic characteristics, tobacco use status, and extent of smoke-free rule enforcement or compliance at home, in the family vehicle, and at school. Statistical comparison of estimates was performed using the χ^2 test ($P < .05$). Multivariate Poisson regression was used to calculate adjusted prevalence ratios for self-reported SHS exposure in each individual environment, as well as overall, assessing for age, gender, school level, race/ethnicity, truant behavior, current use of any tobacco product, tobacco use by household members, tobacco use by close friends, and extent of smoke-free rule enforcement or compliance at home, in the family vehicle, and at school. All data were weighted to yield nationally representative estimates, and data were analyzed with Stata V.13.

RESULTS

Self-Reported SHS Exposure by Location

Among all students, 55.9% reported exposure to SHS in at least 1 setting. When considering reported exposure by setting, 23.9% reported exposure at home, 25.0% in a vehicle, 24.9% at school, 39.7% at work, and 39.9% in an indoor/outdoor public area (Table 1).

Self-Reported SHS Exposure by Tobacco Use

Any SHS exposure reporting differed significantly by tobacco use status (Table 1). Self-reported exposure was 48.0% among never tobacco users, 64.8% among former tobacco users, and 79.9% among current tobacco users ($P < .05$). Among never tobacco users, 15.5% reported exposure to SHS in the home, 14.7% in a vehicle, 16.8% at school, 27.1% at work, and 35.2% in an indoor/outdoor public area. Among never tobacco users who reported any SHS exposure, 23.3% reported daily exposure in at least 1 setting. The source of exposure (not mutually exclusive) among never tobacco users reporting daily exposure was 52% at home, 22.1% in a vehicle, 14.9% at school, 15.6% at work, and 9.5% in an indoor/outdoor public area (Supplemental Table 4). Exclusive current smokeless tobacco users reported significantly lower prevalence of SHS exposure in the home (40.5% vs 53.1% respectively) and in a vehicle (47.1% vs 60.0% respectively), but no significant difference existed in other environments. No significant differences in SHS exposure were observed between exclusive users of cigarettes and e-cigarettes within all assessed environments.

Among all study participants, most reported having complete smoke-free rules in their homes (80.6%), family vehicles (76.1%), and schools (68.6%) (Table 2). Among never

TABLE 1 Prevalence of Self-Reported SHS Exposure Among US Middle and High School Students, NYTS, 2013

Characteristics	Prevalence of ≥ 1 Days of SHS Exposure Within the Past 7 Days % (95% CI)					
	Home <i>n</i> = 17 730	Vehicle <i>n</i> = 17 721	School <i>n</i> = 17 689	Work <i>n</i> = 2803	Indoor/Outdoor Public Area <i>n</i> = 17 574	Any Setting ^a <i>n</i> = 17 805
Overall	23.9 (22.0–25.7)	25.0 (22.8–27.2)	24.9 (23.1–26.8)	39.7 (36.4–43.1)	39.9 (37.6–42.1)	55.9 (53.7–58.1)
Gender						
Girl	25.2 (23.2–27.3)	26.0 (23.4–28.5)	27.1 (24.9–29.3)	39.1 (35.7–42.4)	45.7 (43.0–48.3)	60.4 (57.9–63.0)
Boy	22.5 (20.4–24.6)	24.1 (22.0–26.3)	22.8 (21.0–24.7)	40.2 (35.2–45.2)	34.2 (32.1–36.3)	51.6 (49.3–53.9)
Age (y)						
9–11	17.9 (14.8–21.0)	14.1 (11.1–17.2)	16.7 (12.8–20.7)	43.5 (28.4–58.6)	33.1 (28.4–37.8)	44.5 (40.1–48.8)
12–14	21.6 (19.4–23.7)	20.4 (17.8–23.0)	18.9 (17.1–20.7)	42.3 (35.1–49.4)	36.1 (33.7–38.6)	50.8 (48.4–53.2)
15–17	25.8 (23.4–28.1)	28.8 (26.1–31.5)	30.2 (27.6–32.8)	39.1 (35.6–42.7)	43.0 (40.3–45.8)	60.9 (58.4–63.4)
≥ 18	30.5 (26.6–34.5)	36.2 (32.4–40.0)	34.4 (31.1–37.7)	38.9 (33.8–44.1)	47.0 (43.3–50.7)	65.1 (61.4–68.7)
Grade level						
Middle school (grades 6–8)	21.0 (18.6–23.5)	19.7 (17.0–22.5)	17.2 (15.5–18.8)	42.1 (34.5–49.6)	34.9 (32.4–37.3)	49.0 (46.6–51.5)
6th	18.4 (15.7–21.1)	16.3 (13.6–19.0)	13.7 (11.5–15.9)	36.5 (26.2–46.8)	29.7 (26.4–32.9)	43.1 (39.7–46.6)
7th	22.0 (19.1–24.9)	20.2 (16.9–23.5)	18.0 (15.9–20.1)	43.6 (31.1–56.1)	34.1 (31.0–37.2)	48.7 (45.4–52.0)
8th	22.6 (19.5–25.8)	22.7 (19.2–26.1)	19.8 (17.3–22.2)	46.6 (37.2–56.0)	40.7 (37.4–44.0)	55.3 (52.4–58.2)
High school (grades 9–12)	25.9 (23.7–28.1)	29.0 (26.5–31.5)	30.7 (28.2–33.2)	38.9 (35.6–42.2)	43.5 (40.7–46.4)	61.2 (58.7–63.7)
9th	25.2 (22.5–27.9)	26.2 (23.2–29.3)	29.3 (25.5–33.1)	47.8 (38.0–57.5)	42.3 (38.6–46.0)	58.8 (56.0–61.7)
10th	26.1 (23.4–28.8)	28.3 (25.1–31.4)	30.4 (27.2–33.6)	38.5 (31.8–45.2)	41.4 (37.7–45.1)	59.3 (55.7–62.8)
11th	26.5 (23.3–29.7)	30.3 (26.3–34.3)	32.3 (28.8–35.7)	37.4 (32.4–42.4)	43.5 (40.3–46.7)	62.4 (59.2–65.7)
12th	26.1 (22.6–29.6)	31.8 (27.9–35.6)	31.1 (28.0–34.3)	37.3 (32.9–41.7)	47.4 (44.0–50.8)	64.8 (61.2–68.5)
Race/ethnicity						
White, non-Hispanic	25.1 (22.9–27.3)	27.2 (24.6–29.7)	24.6 (22.5–26.6)	38.2 (34.6–41.8)	40.3 (37.9–42.6)	57.5 (55.1–60.0)
Black, non-Hispanic	22.4 (20.3–24.4)	21.6 (19.0–24.3)	27.0 (24.8–29.2)	44.2 (39.5–48.8)	40.0 (36.9–43.1)	54.3 (51.6–57.1)
Hispanic	14.1 (10.9–17.2)	9.9 (7.2–12.7)	25.8 (17.0–34.6)	37.6 (24.3–50.8)	43.5 (31.4–55.6)	52.6 (41.8–63.3)
Other, non-Hispanic ^b	22.7 (17.2–28.1)	20.1 (15.3–24.8)	26.3 (20.0–32.6)	45.4 (29.8–61.0)	37.8 (30.2–45.4)	51.9 (43.7–60.0)
Truant behavior in past 12 mo						
No	20.3 (18.6–22.1)	20.7 (18.5–22.9)	20.4 (18.4–22.5)	31.1 (27.9–34.4)	36.0 (33.5–38.5)	51.6 (49.0–54.1)
Yes	39.3 (36.3–42.3)	43.8 (40.4–47.2)	44.6 (41.8–47.3)	55.1 (50.4–59.8)	57.2 (54.5–59.9)	75.6 (73.4–77.9)
Tobacco use status						
Never any tobacco user ^c	15.5 (14.1–16.9)	14.7 (13.1–16.3)	16.8 (14.8–18.7)	27.1 (20.9–33.4)	35.2 (32.6–37.7)	48.0 (45.6–50.4)
Former any tobacco user ^d	30.8 (28.1–33.5)	32.9 (29.8–36.1)	32.4 (29.7–35.1)	35.3 (29.2–41.5)	44.0 (41.1–47.0)	64.8 (62.3–67.4)
Current any tobacco user ^e	48.3 (45.2–51.5)	57.5 (54.6–60.4)	48.4 (45.5–51.3)	55.3 (50.8–59.8)	55.0 (52.0–58.1)	79.9 (77.6–82.3)
Exclusive cigarette smoker ^f	53.1 (46.4–59.8)	60.0 (53.1–66.9)	40.1 (33.8–46.4)	49.4 (36.4–62.3)	54.1 (47.8–60.5)	81.6 (75.6–87.7)
Exclusive smokeless tobacco user ^g	40.5 (32.7–48.2)	47.1 (39.4–54.9)	31.4 (23.1–39.7)	33.9 (19.7–48.1)	43.7 (35.6–51.7)	73.9 (67.4–80.4)
Exclusive electronic cigarette user ^h	47.8 (34.4–61.2)	45.9 (30.0–61.8)	41.2 (27.8–54.5)	72.9 (54.9–90.8)	50.1 (36.8–63.4)	76.3 (64.4–88.3)

^a Self-reported exposure to SHS in ≥ 1 of the 5 environments assessed: at home, in a vehicle, at school, at work, and in any indoor/outdoor public area.

^b Includes American Indian or Alaska Native; and Native Hawaiian or other Pacific Islander.

^c Never tobacco users were students who reported never using any of the following tobacco products in their lifetime: cigarettes/flavored cigarettes, roll-your-own tobacco, cigars/flavored cigars, pipes, bidis, kreteks, hookahs, electronic cigarettes (e-cigarettes), smokeless tobacco (dissolvable tobacco, chewing tobacco/snuff/dip, or snus), or "some other new tobacco products not listed."

^d Former tobacco users were students who had ever used any of the aforementioned products during their lifetime but had not used any of these products within the past 30 days.

^e Current tobacco users were students who had used any of the aforementioned products on at least 1 day during the past 30 days.

^f Exclusive cigarette smokers were students who reported using cigarettes within the past 30 days but no other tobacco product.

^g Exclusive smokeless tobacco users were students who reported using smokeless tobacco (dissolvable tobacco, chewing tobacco/snuff/dip, or snus) within the past 30 days but no other tobacco product.

^h Exclusive electronic cigarette users were students who reported using electronic cigarettes within the past 30 days but no other tobacco product.

tobacco users, prevalence of self-reported SHS exposure in the home was 8.5%, 55.3%, and 79.4% among those with complete, partial, or no smoke-free home rules, respectively ($P < .05$). Similarly, prevalence of self-reported SHS exposure in a vehicle was 7.1%, 44.8%, and 70.2% among never tobacco users with complete, partial, or no smoke-free vehicle rules, respectively ($P < .05$). Prevalence of self-reported SHS exposure in school was 11.8% among never tobacco users who reported completely enforced smoke-free school policies and 32.9% among those not reporting completely enforced smoke-free school policies ($P < .05$).

Determinants of Self-Reported SHS

After multivariate adjustment, adolescent boys had lower likelihood than adolescent girls of reporting exposure to any SHS overall (adjusted prevalence ratio [APR] = 0.86; 95% confidence interval [CI] = 0.83–0.90), as well as within most environments assessed; the only exception was at work and home, where no significant gender difference existed in self-reported exposure (Table 3). Students in high school had higher likelihood than middle school students of reporting exposure to SHS in school (APR = 1.30; 95% CI = 1.10–1.53) but did not differ significantly in reporting SHS exposure from other environments. The likelihood of reporting SHS exposure in vehicles were lower among Hispanics (APR = 0.57; 95% CI = 0.44–0.74) and non-Hispanics of other races (APR = 0.76; 95% CI = 0.62–0.93) when compared with non-Hispanic whites. Non-Hispanic blacks had higher likelihood of reporting exposure to SHS in school and at work compared with non-Hispanic whites (APR = 1.14, and 1.19, respectively; $P < .05$).

Other factors associated with higher likelihood of self-reported SHS exposure overall and in each

of the 5 environments assessed included current any tobacco use, truant behavior, having a household member who used tobacco and having a close friend who used tobacco. Presence of complete smoke-free rule at home was associated with lower likelihood of reporting SHS exposure in any setting (APR = 0.94; 95% CI = 0.90–0.98); at home (APR = 0.58; 95% CI = 0.53–0.62); in school (APR = 0.88; 95% CI = 0.79–0.99); and at work (APR = 0.84; 95% CI = 0.72–0.98), compared with no smoke-free rule at home. In contrast, partial smoke-free rule at home was associated with higher likelihood of reporting SHS exposure in any setting and in a vehicle (APR = 1.06; 95% CI = 1.02–1.11; and APR = 1.11; 95% CI = 1.02–1.21, respectively). Compared with no smoke-free rule, complete smoke-free rule in vehicles was associated with lower exposure to SHS in all settings. Compliance with complete smoke-free rule at school was associated with lower prevalence ratios for all settings, except at home, compared with a partial compliance with smoke-free rules.

DISCUSSION

This study demonstrated that nearly half (48.0%) of US middle and high school students who have never used tobacco were exposed to SHS in 2013. Self-reported SHS exposure in the home or in a vehicle was more than ninefold higher among never tobacco users with no smoke-free home or car rules than those with 100% smoke-free rules. Furthermore, homes and vehicles were the settings where the highest percentage of never tobacco users reported daily SHS exposure. These findings underscore the importance of enhanced implementation of smoke-free home and vehicle rules in conjunction with continued efforts to implement comprehensive smoke-free laws in public places. Strongly

enforced smoke-free policies can protect nonsmokers from SHS, help denormalize tobacco use, and can support youth tobacco-use prevention and cessation efforts.

Although tremendous progress has been made in the past decade in the United States in protecting youths from SHS in public areas, this study showed that public areas remain the most frequent source of exposure to SHS among US middle and high school students. Public places, such as sport venues, restaurants, or airports, which provide exemptions to smoke free laws (eg, designated smoking areas), could be potential sources of SHS for children because of drifting of SHS. Parents could make efforts to deliberately reduce their children's exposure to SHS in public places in several way, including not allowing people to smoke around them, moving away or deciding against staying in places where smoking is occurring, and educating their children on the dangers of SHS exposure and the need to avoid environments where smoking may be likely to occur

Despite having a significantly lower cigarette smoking prevalence,¹⁵ adolescent girls were more likely than adolescent boys to report any SHS exposure, a finding that has been observed in several other studies.^{11,12} Indeed, research shows that female youths are more likely than their male counterparts to perceive SHS as being harmful¹⁶ and hence may be more likely to remember an encounter of SHS exposure. Other inequalities in SHS exposure noted in our study, such as the disproportionately higher prevalence among high school, non-Hispanic white, and truant students, might be attributable to higher prevalence of cigarette smoking among these subgroups.¹⁵ Additionally, SHS exposure among former tobacco users (64.8%) was lower than current tobacco users (79.9%) but higher than never tobacco users

TABLE 2 Prevalence of Self-Reported SHS Exposure at Home, in a Vehicle, and at School, by Extent of Smoke-Free Rules Among US Middle and High School Students, NYTS, 2013

Setting of SHS Exposure ^a	Prevalence of ≥ 1 Days of SHS Exposure Within the Past 7 Days % (95% CI)							
	Distribution of Students by Extent of Smoke-Free Rule % (95% CI)	Overall	Never Tobacco User ^b	Former Tobacco User ^c	Current Tobacco User ^d	Exclusive Cigarette Smoker ^e	Exclusive Smokeless Tobacco User ^f	Exclusive Electronic Cigarette User ^g
	n = 18406	n = 18406	n = 10994	n = 2878	n = 2829	n = 395	n = 172	n = 88
Home								
No smoke-free rules	8.7 (7.5–9.9)	81.8 (79.1–84.5)	79.4 (75.1–83.8)	80.6 (75.0–86.1)	86.0 (81.9–90.1)	85.9 (76.9–95.0)	84.8 (67.3–100.0)	90.3 (81.3–99.5)
Partial smoke-free rules	10.8 (9.8–11.9)	60.9 (57.7–64.1)	55.3 (51.0–59.5)	61.4 (54.2–68.7)	71.9 (65.8–78.1)	77.6 (64.7–90.4)	66.7 (46.3–87.1)	72.9 (50.7–95.2)
Complete smoke-free rules	80.6 (78.5–82.5)	12.6 (11.6–13.6)	8.5 (7.6–9.4)	17.2 (14.7–19.7)	28.9 (26.3–31.6)	32.0 (24.1–39.9)	25.1 (15.3–34.9)	35.1 (19.5–50.6)
Vehicle								
No smoke-free rules	12.0 (10.6–13.5)	78.7 (75.7–81.8)	70.2 (64.7–75.7)	78.5 (74.1–82.9)	87.7 (84.6–90.7)	85.5 (77.4–93.7)	73.0 (56.2–89.8)	89.1 (79.7–98.5)
Partial smoke-free rules	12.0 (11.0–13.0)	54.2 (51.7–56.8)	44.8 (41.0–48.6)	54.9 (49.0–60.8)	73.7 (68.3–79.1)	60.1 (48.0–72.3)	65.2 (38.7–87.6)	62.3 (32.3–92.4)
Complete smoke-free rules	76.1 (73.9–78.1)	12.0 (10.8–13.2)	7.1 (6.0–8.1)	15.8 (13.8–17.9)	36.8 (33.7–40.0)	41.2 (30.8–51.7)	29.8 (20.1–39.5)	26.5 (9.1–43.9)
School								
No report of complete smoke-free rule compliance	31.4 (28.1–34.9)	43.7 (40.8–46.7)	32.9 (29.0–36.9)	43.2 (38.7–47.8)	59.4 (55.7–63.0)	30.1 (21.1–39.0)	22.7 (7.2–38.2)	41.9 (21.4–62.4)
Report of complete smoke-free rule compliance	68.6 (65.1–71.9)	16.4 (14.9–17.8)	11.8 (10.3–13.2)	25.2 (22.0–28.4)	33.9 (30.0–37.8)	54.7 (44.3–65.2)	34.6 (23.2–46.1)	43.8 (24.6–62.9)

^a Self-Reported SHS exposure in the home, in a vehicle, or at school was defined as a report by a student that he or she had breathed the smoke from someone who was smoking tobacco products in the specified environment within the past 7 days.
^b Never tobacco users were students who reported never using any of the following tobacco products in their lifetime: cigarettes/flavored cigarettes, roll-your-own tobacco, cigars/flavored cigars, pipes, bidis, kreteks, hookahs, electronic cigarettes (e-cigarettes), smokeless tobacco (dissolvable tobacco, chewing tobacco/snuff/dip, or snus), or "some other new tobacco products not listed."
^c Former tobacco users were students who had ever used any tobacco products during their lifetime but did not use any of these products within the past 30 days.
^d Current tobacco users were students who had used any tobacco products on at least 1 day during the past 30 days.
^e Exclusive cigarette smokers were students who reported using cigarettes within the past 30 d, but no other tobacco product.
^f Exclusive smokeless tobacco users were students who reported using smokeless tobacco (dissolvable tobacco, chewing tobacco/snuff/dip, or snus) within the past 30 days but no other tobacco product.
^g Exclusive electronic cigarette users were students who reported using electronic cigarettes within the past 30 days but no other tobacco product.

(48.0%). This finding might be due to former tobacco users' socialization with smoking peers or exposure to environments where smoking might be occurring, which could serve as social, behavioral, or environmental cues that trigger smoking relapse, especially in places with no prohibitions on sales of emerging tobacco products to minors, or use of such tobacco products in public places^{17,18,19}

Current tobacco use by a household member was associated with higher likelihood of reporting SHS exposure in the home, family car, and other environments. Health care professionals can play a vital role in reducing children's SHS exposure, especially in private settings such as the home and vehicles, by counseling smoking parents and other caretakers who might accompany their children during pediatric visits. Pediatric clinicians have direct contact with a quarter of the nation's smokers through child health visits and can be an important source of smoking cessation counseling for parents who are uninsured but have their children covered by Medicaid.²⁰ Engaging parents who smoke in brief smoking cessation counseling has been shown to increase rates of quit attempts by parents and is recommended by the American Academy of Pediatrics.^{20,21}

Notably, for all environments that were assessed, no significant differences in self-reported SHS exposure were observed between exclusive users of cigarettes or e-cigarettes. Use of e-cigarettes and other electronic nicotine delivery system (ENDS) in public indoor areas might passively expose bystanders (eg, children, nonsmokers) to nicotine and other potentially harmful constituents.^{22–28} Moreover, some ENDS can be modified to deliver marijuana and other psychoactive substances.²⁹ Prohibitions on ENDS use in public places are critical to maintain clean indoor air standards and to help

TABLE 3 APRs of Factors Associated With Self-Reported SHS Exposure Among US Middle and High School Students, NYTS, 2013

Characteristics	Categories					Any Setting ^a	
	Home	Vehicle	School	Work	Indoor/Outdoor Public Area		
Gender	Girl (ref)						
Age (y)	Boy	0.96 (0.90–1.02)	0.94 (0.89–0.99)*	0.81 (0.77–0.86)*	0.95 (0.84–1.11)	0.76 (0.72–0.8)*	0.86 (0.83–0.90)*
	9–11 (ref)						
	12–14	1.06 (0.90–1.25)	1.12 (0.92–1.37)	0.92 (0.72–1.17)	1.40 (0.87–2.25)	1.03 (0.91–1.17)	1.04 (0.96–1.13)
	15–17	0.99 (0.83–1.18)	1.22 (0.99–1.52)	0.85 (0.61–1.18)	1.43 (0.83–2.45)	0.98 (0.81–1.18)	1.02 (0.91–1.15)
School level	≥18	0.95 (0.76–1.17)	1.22 (0.98–1.52)	0.80 (0.56–1.13)	1.32 (0.79–2.19)	0.96 (0.78–1.17)	0.99 (0.86–1.14)
	Middle (ref)						
Race/ethnicity	High	1.01 (0.89–1.14)	0.94 (0.82–1.07)	1.30 (1.10–1.53)*	0.85 (0.66–1.10)	1.01 (0.88–1.17)	1.04 (0.96–1.13)
	White, non-Hispanic (ref)						
	Black, non-Hispanic	1.04 (0.96–1.12)	0.93 (0.84–1.02)	1.14 (1.07–1.23)*	1.19 (1.05–1.36)*	1.01 (0.94–1.08)	0.98 (0.94–1.03)
	Hispanic	0.83 (0.68–1.02)	0.57 (0.44–0.74)*	1.26 (0.93–1.71)	1.20 (0.83–1.74)	1.20 (0.93–1.55)	1.03 (0.85–1.25)
Current any tobacco use ^{c,d}	Other, non-Hispanic ^b	0.98 (0.78–1.21)	0.76 (0.62–0.93)*	1.09 (0.92–1.30)	1.08 (0.74–1.57)	0.95 (0.79–1.15)	0.90 (0.79–1.02)
	Nonuser (ref)						
	Current user	1.16 (1.08–1.25)*	1.42 (1.33–1.51)*	1.22 (1.15–1.30)*	1.26 (1.05–1.50)*	1.04 (0.98–1.10)	1.05 (1.02–1.08)*
	No (ref)						
Truant behavior in past 12 mo	Yes	1.13 (1.06–1.20)*	1.18 (1.10–1.27)*	1.27 (1.16–1.40)*	1.31 (1.15–1.50)*	1.23 (1.16–1.30)*	1.13 (1.08–1.18)*
	None (ref)						
Tobacco use by close friends	≥1	1.18 (1.10–1.27)*	1.40 (1.33–1.47)*	1.58 (1.44–1.73)*	1.23 (1.08–1.41)*	1.36 (1.29–1.44)*	1.28 (1.25–1.32)*
	None (referent)						
Tobacco use by household members	≥1	5.93 (4.93–7.13)*	2.17 (1.97–2.39)*	1.48 (1.34–1.63)*	1.26 (1.09–1.47)*	1.08 (1.01–1.15)*	1.39 (1.33–1.45)*
	None						
Extent of smoke-free home rule	Partial	1.00 (0.93–1.07)	1.11 (1.02–1.21)*	1.04 (0.93–1.16)	0.90 (0.77–1.04)	1.03 (0.95–1.12)	1.06 (1.02–1.11)*
	Complete	0.58 (0.53–0.62)*	0.98 (0.89–1.07)	0.88 (0.79–0.99)*	0.84 (0.72–0.98)*	0.93 (0.86–1.01)	0.94 (0.90–0.98)*
Extent of smoke-free vehicle rule	None						
	Partial	0.89 (0.82–0.97)*	0.82 (0.76–0.88)*	1.02 (0.93–1.13)	1.00 (0.87–1.16)	0.90 (0.82–0.98)*	0.97 (0.93–1.01)
Extent of compliance with school smoke-free rule	Complete	0.53 (0.47–0.59)*	0.32 (0.28–0.35)*	0.82 (0.75–0.91)*	0.77 (0.65–0.92)*	0.85 (0.78–0.92)*	0.79 (0.75–0.83)*
	Partial						
Complete	0.95 (0.90–1.00)	0.88 (0.82–0.94)*	0.55 (0.51–0.60)*	0.79 (0.67–0.94)*	0.73 (0.68–0.77)*	0.84 (0.80–0.87)*	

Multiple Poisson regression models were fitted to assess determinants of self-reported SHS exposure in the different environments. Multivariate models included all variables listed in table. Ref, referent. *Statistically significant results at $P < .05$.
^a Self-reported exposure to secondhand smoke in ≥1 of the 5 environments assessed: at home, in a vehicle, at school, at work, and in any indoor/outdoor public area.
^b Includes American Indian or Alaska Native, and Native Hawaiian or other Pacific Islander.
^c Current any tobacco users were students who reported using any of the following tobacco products in the past 30 days: cigarettes/ flavored cigarettes, roll-your-own tobacco, cigars/ flavored cigars, pipes, bidis, kreteks, hookahs, electronic cigarettes (e-cigarettes), smokeless tobacco (dissolvable tobacco, chewing tobacco/snuff/dip, or snus), or "some other new tobacco products not listed."
^d Current cigarette smokers were students who reported using cigarettes within the past 30 days (not mutually exclusive of other tobacco products).

support tobacco-free norms.¹⁷ In addition, such restrictions could simplify and enhance smoke-free law enforcement because some ENDS use can be difficult to distinguish from conventional smoking.¹⁷

These findings emphasize the importance of implementing interventions to protect children in private environments, including in multiunit housing and in vehicles. Some states have implemented smoke-free laws prohibiting smoking in public multiunit housing and in private vehicles when children are present.⁴ Research also shows an increase in the number of public housing authorities, municipalities, and operators of private market-rate multiunit housing that have implemented smoke-free building policies prohibiting smoking in indoor areas, including living units.³⁰ Such policies are important in reducing exposure among children, considering that children occupy at least one-third of US households.³¹

The findings in this study are subject to at least 3 limitations. First, because SHS exposure was self-reported and not confirmed by biological markers such as

serum cotinine, the findings may have been subject to misreporting when compared with studies using objective biomarkers of exposure.^{5,32} However, self-reported SHS exposure is a valid measure that has been used in several epidemiologic studies.^{6,11–13,33} Second, NYTS data may not be generalizable to youth who are being homeschooled, those that have dropped out of school, or those in detention centers. However, data from the Current Population Survey indicate that 98.2% of US youth aged 10 to 13 years and 96.1% of those aged 14 to 17 years were enrolled in a traditional school in 2013.³⁴ Finally, respondents could potentially have been exposed to SHS from other sources not assessed in NYTS. Moreover, we only assessed recent (past 7-day) exposure, which may underestimate prevalence of exposure among occasionally exposed individuals not captured by a measure of past 7-day exposure.

CONCLUSIONS

In summary, in 2013, nearly 6 in 10 US middle and high school students, including approximately half (48.0%) of never tobacco users, reported

exposure to SHS. Never tobacco users with no smoke-free home or vehicle rules reported significantly higher levels of SHS exposure compared with those with 100% smoke-free rules. This underscores the importance of implementing voluntary 100% smoke-free home and vehicle rules, in concert with comprehensive smoke-free laws that prohibit smoking in all indoor areas of workplaces, bars, restaurants, and other public areas, to protect nonsmokers from SHS exposure. These findings also indicate that opportunities exist for intensified tobacco educational programs targeted at youths, particularly former tobacco users, on the importance of avoiding SHS exposure.

ABBREVIATIONS

APR: adjusted prevalence ratio
CI: confidence interval
ENDS: electronic nicotine delivery system
NYTS: National Youth Tobacco Survey
SHS: secondhand smoke

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