



Disparities in the frequency of tobacco products use by sexual identity status

Sunday Azagba^{*}, Lingpeng Shan

Department of Family and Preventive Medicine, University of Utah School of Medicine, United States

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ABSTRACT

Background: Largely absent from the literature are studies examining differences in tobacco use frequency among sexual minority populations versus heterosexuals. The current study examined the frequency of tobacco product use (i.e., cigarette, e-cigarettes and cigars, smokeless tobacco, hookah, and heated tobacco products) among sexual minority students versus heterosexuals (straight).

Methods: Data from the 2020 National Youth Tobacco Survey ($n = 14,531$) were analyzed to examine the association between sexual identity (lesbian or gay, bisexual, not sure, and heterosexual or straight) and tobacco use frequency. Negative binomial regression and zero-inflated negative binomial models were used to assess the association between sexual identity and each tobacco use frequency among current and ever users.

Results: Current e-cigarettes users who identified as gay or lesbian used e-cigarette more frequently than heterosexual students. Multivariable count regression analysis showed that the e-cigarette use frequency in the past 30 days was significantly higher for gays or lesbians (IRR 1.45, 95% CI, 1.19–1.76) compared to heterosexuals. Similarly, gay or lesbian students who were current hookah users on average reported 81% more days of hookah use (IRR, 1.81, 95% CI, 1.08–3.03). The frequency of cigarette smoking was also significantly higher among bisexual cigarette smokers. No significant differences were found in other tobacco product use frequencies between sexual minority and heterosexual youths.

Conclusion: Sexual identity was associated with tobacco use frequency, especially for e-cigarettes and hookah. Elevated tobacco use among sexual minority groups deserves special consideration among a population group that is highly vulnerable to marketing and advertisement targeting.

1. Introduction

Tobacco use is the leading cause of preventable disease and death in the United States, accounting for nearly half a million deaths each year; almost all tobacco product use begins during youth and young adulthood (National Center for Chronic Disease Prevention and Health Promotion, 2014). Current smoking prevalence has decreased from 15.8% and 4.3% in 2011 for high school and middle school students to 4.6% and 1.6% in 2020, respectively (Wang et al., 2018; Gentzke et al., 2020). Comprehensive implementation of evidence-based tobacco prevention and control strategies at national, state, and local levels might have contributed to such a reduction recently (National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2012). The proliferation and popularity of emerging tobacco products have raised concerns that tobacco control progress might be

impacted, especially among youth. For example, since the introduction of e-cigarette in the middle-2000 s, it has become the most commonly used tobacco product in middle and high school students since 2014. Approximately one in five high school students and one in 21 middle school students were current e-cigarettes users in 2020 (Wang et al., 2018; Gentzke et al., 2020).

Tobacco use rates remain disproportionately high in various sub-populations, including sexual minority populations (Gentzke et al., 2020; Kasza et al., 2017; Hinds et al., 2018; Fallin-Bennett et al., 2017; Fish et al., 2019; Dai, 2017). Evidence suggests that bisexual youth, particularly girls, have a heightened risk of cigarette smoking (Azagba et al., 2019; Marshal et al., 2008, 2012). Elsewhere, a prior study found that sexual minority girls experienced escalated smoking rates during the transition into young adulthood compared to heterosexual girls (Marshal et al., 2012). Several reasons could explain the elevated

^{*} Corresponding author at: Department of Family and Preventive Medicine, Division of Public Health, University of Utah, 375 Chipeta Way, Suite A, Salt Lake City, UT 84108, United States.

E-mail address: sunday.azagba@utah.edu (S. Azagba).

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cigarette smoking among sexual minorities, including the disproportionate amounts of daily stress due to discrimination and victimization (Ryan et al., 2001; Meyer, 2003; Hatzenbuehler et al., 2014). A prospective study by Hatzenbuehler and his colleagues found that sexual minority youths living in low structural stigma states were less likely to report cigarette smoking, and this association was not significant among heterosexual youth (Hatzenbuehler et al., 2014). Aggressive marketing activities targeting sexual minority populations might be another explanation (Dilley et al., 2008; Washington, 2002; Emory et al., 2019). A previous study found that sexual minorities, particularly smokers, were more likely to interact with tobacco-related marketing, including e-cigarettes on new and social media, than heterosexual peers (Emory et al., 2019).

A preponderance of the extant literature has primarily examined cigarette smoking status between sexual minority populations and heterosexuals (Azagba et al., 2019; Marshal et al., 2008, 2012). However, largely absent from the literature are studies examining differences in the frequency of use among sexual minority populations versus heterosexuals. Though there is no risk-free level in tobacco use, understanding potential differences in the frequency of use is essential. Evidence suggests that non-daily tobacco use is a transitional phase between daily use and cessation (Hughes and Carpenter, 2006; Schane et al., 2010; Evans et al., 1992). Prior studies have documented distinct motives for tobacco use at different using frequencies, and, thus, specific barriers to cessation existed (Berg et al., 2012). Additionally, there is limited research on other tobacco products among sexual minority populations (Garcia et al., 2021; Dermody, 2018), in part, due to a lack of nationally representative data. The 2020 National Youth Tobacco Survey (NYTS) added a sexual identity measure, which provides an opportunity to understand the health and well-being of sexual identity youth at the population level. The current study used data from the 2020 NYTS to examine the frequency of tobacco product use (i.e., cigarette, e-cigarettes and cigars, smokeless tobacco, hookah, and heated tobacco products) among sexual minority groups versus heterosexuals.

2. Methods

2.1. Data

The NYTS was designed to provide comprehensive national data on tobacco-related indicators for middle school (grades 6–8) and high school (grades 9–12) to support the design, implementation, and evaluation of state and national tobacco prevention control programs. Tobacco-related indicators included in the NYTS are tobacco use (e-cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, roll-your-own cigarettes, pipes, snus, dissolvable tobacco, bidis, and heated tobacco products); exposure to secondhand smoke and e-cigarette aerosol; smoking cessation; minor ability to purchase or obtain tobacco products; knowledge and attitudes about tobacco; and familiarity with pro-tobacco and anti-tobacco media messages. The 2020 NYTS is a probability-based design using a stratified, three-stage cluster sample, resulting in a nationally representative sample of middle school and high school students in the United States (Office on Smoking and Health, 2020). For each year, students in randomly selected U.S. states and the District of Columbia were invited to participate; participation was confidential, voluntary, and approved by parents. During a regular class period, participants were provided with a tablet to complete the survey using a programmed survey application. Students absent or unavailable on the day of the survey administration could participate in make-up surveys using a web-based version of the questionnaire programmed to mimic the tablet-based application. Due to the COVID-19 pandemic, data collection was ended early on March 16, 2020, which was expected to be May 15, 2020. The final sample consisted of 361 schools, of which 180 participated before school closures, with school participation of 49.9% and 87.4% of students completed questionnaires, which yielded the overall participation rate, 43.6% (i.e., the product of the school-level

and student-level participation rates). This secondary analysis of deidentified publicly available data is exempt from the University of Utah Institutional Review Board IRB oversight or further review.

2.2. Measures

The outcome variable, tobacco use frequency, was derived among current users (i.e., any past-30 day use). The frequency of cigarette use was defined as the number of days respondents smoked cigarettes during the past 30 days. Similarly, we derived the frequency of use for cigars, chewing tobacco, snuff, or dip, electronic cigarettes, hookah, and heated tobacco products.

The main independent variable is sexual identity. Sexual identity, measured by the question, “which of the following best describes you?” The possible responses included “Heterosexual (straight),” “Lesbian or Gay,” “bisexual,” and “Not Sure.” In terms of other independent variables, exposure to tobacco marketing, ranging from 0 to 9, defined as the number of exposure to ads or promotions for tobacco products and e-cigarettes. Venues of ads or promotions include Internet, newspapers or magazines, convenience stores, supermarkets, or gas stations, watch TV or streaming services (such as Netflix, Hulu, or Amazon Prime), go to the movies, and on social media (such as YouTube, Instagram, Snapchat, Twitter, or Facebook). The frequency of ads or promotion exposure was recoded with options “Do not use,” “Never,” and “Rarely,” as 0 and options “Sometimes,” “Most of the time,” and “Always” as one was included to derive the sum, exposure to tobacco marketing. Additionally, demographic characteristics were obtained from the data, including grade, sex (male and female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic other), and tobacco use by household members (Yes and No).

2.3. Statistical analyses

The sample characteristics were reported with weighted percentages and their 95% confidence interval. Demographic characteristics were described by sexual identity groups (heterosexual (straight, lesbian or gay, bisexual, not sure). The weighted data (frequency and mean) were reported for all categorical and continuous variables, respectively. ANOVA tests and Rao-Scott Chi-Square tests were used to compare characteristics among groups. For current smokers (students who smoked cigarettes at least one day during the past 30 days), the average frequency of smoking was estimated for the full middle school and high school student sample and for sexual identity subgroups separately. ANOVA tests were used to compare the mean estimation among groups. Multivariable negative binomial regression models were used to assess the association between sexual identity and smoking frequency for current smokers. Negative binomial count regressions were used to relax the Poisson equidispersion restrictive assumption (i.e., the variance equals the mean). Additional analyses were conducted to examine past-30 day tobacco use frequency and sexual identity among ever smokers. We used zero-inflated negative binomial regression to account for excess zeros in the frequency measure among ever users. A similar approach was adopted for other tobacco products (cigars, chewing tobacco, snuff, or dip, electronic cigarettes, hookah, and heated tobacco products). All the multivariable analysis adjusted for grade level, sex, race/ethnicity, exposure to tobacco marketing, and household members' tobacco use. Sampling weights were included in all analyses to account for the complex survey design. All tests were two-sided, and a p -value < 0.05 was considered significant. All analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

3. Results

Table 1 reports descriptive statistics of the study population by sexual identity. Of 14,531 students, 82.2% (11,500) were heterosexual (straight), 2.8% (386) were lesbian or gay, 7.1% (984) were bisexual,

Table 1

Descriptive statistics of the study population by sexual identity, 2020 National Youth Tobacco Survey (n = 14,531).

	General population	Heterosexual (straight)	Gay or Lesbian	Bisexual	Not Sure	p-value
N	14,531	11,500	386	984	1155	
Grade						<0.0001
6th	14.72(12.09, 17.34)	12.80(10.51, 15.09)	11.74(7.47, 16.02)	10.25(6.62, 13.89)	37.90(31.79, 44.02)	
7th	14.51(12.10, 16.91)	14.49(12.05, 16.94)	15.13(8.48, 21.78)	12.85(8.94, 16.76)	15.88(12.54, 19.22)	
8th	14.50(12.20, 16.80)	14.92(12.60, 17.24)	11.65(6.96, 16.33)	13.96(10.34, 17.57)	12.11(8.84, 15.38)	
9th	15.04(13.11, 16.96)	15.52(13.53, 17.51)	17.39(11.59, 23.20)	14.97(10.72, 19.23)	9.62(6.60, 12.65)	
10th	14.35(12.58, 16.12)	14.78(13.03, 16.53)	17.56(11.91, 23.21)	13.38(10.56, 16.20)	10.21(7.21, 13.20)	
11th	13.69(12.13, 15.26)	14.03(12.38, 15.68)	11.51(6.95, 16.08)	17.21(13.33, 21.08)	8.05(5.16, 10.95)	
12th	13.20(11.51, 14.89)	13.46(11.74, 15.18)	15.01(10.11, 19.91)	17.38(13.54, 21.22)	6.22(3.92, 8.52)	
Sex						<0.0001
Male	50.63(49.40, 51.87)	53.35(51.88, 54.83)	46.37(39.08, 53.67)	20.35(16.67, 24.03)	49.41(45.74, 53.09)	
Female	49.37(48.13, 50.60)	46.65(45.17, 48.12)	53.63(46.33, 60.92)	79.65(75.97, 83.33)	50.59(46.91, 54.26)	
Race/ethnicity						<0.0001
non-Hispanic white	48.63(43.79, 53.47)	50.02(45.03, 55.02)	51.36(43.65, 59.07)	43.91(38.29, 49.52)	42.40(35.56, 49.24)	
non-Hispanic Black	11.70(9.08, 14.32)	11.68(9.02, 14.33)	14.63(8.98, 20.28)	11.86(8.43, 15.29)	9.54(6.05, 13.03)	
Hispanic	26.51(22.39, 30.64)	25.78(21.58, 29.98)	24.18(18.43, 29.94)	29.87(24.43, 35.30)	27.28(19.17, 35.38)	
non-Hispanic Other	13.15(10.33, 15.98)	12.53(9.84, 15.21)	9.83(6.22, 13.43)	14.37(11.46, 17.28)	20.78(12.81, 28.74)	
Exposure to tobacco marketing	3.40(3.29, 3.50)	3.42(3.33, 3.52)	3.85(3.47, 4.23)	3.68(3.43, 3.93)	2.82(2.54, 3.10)	<0.0001
Tobacco use by household members						<0.0001
Yes	35.17(32.81, 37.52)	33.68(31.13, 36.24)	48.59(42.14, 55.04)	51.37(46.69, 56.06)	31.48(27.34, 35.62)	
No	64.83(62.48, 67.19)	66.32(63.76, 68.87)	51.41(44.96, 57.86)	48.63(43.94, 53.31)	68.52(64.38, 72.66)	

¹Categorical characteristics are presented in weighted column percentages (95% confidence interval) while continuous characteristic, exposure to tobacco marketing, is presented in weighted mean (95% confidence interval).

²Rao-Scott chi-square test was used to detect significant differences among groups.

and remaining 7.8% (1155) were not sure. Compared with straight adolescents, demographic and socioeconomic characteristics of sexual minorities were significantly different. Heterosexual (straight) students were more likely to be male (53.4%), and sexual minorities were more likely to be female (53.6% for lesbian or gay and 79.7% for bisexual). Students who were not sure about their sexual identity had the highest percentage of students in 6th grade (37.9%). Students who were not sure also had the lowest percentage of students living with tobacco users (31.5%).

Table 2 presents the population estimates of tobacco use frequency among current users by sexual identity. In 2020, the most frequently used tobacco products were e-cigarettes, where current e-cigarettes users reported using roughly every other day (mean = 13.1, 95% confidence interval (CI), 12.2–14.0) in the past 30 days. By comparison, the frequency of use reported by current hookah and cigars users was 8.6 and 7.9 days, respectively. Tobacco use patterns differed significantly by the sexual identity for all tobacco products. On average, current e-cigarettes users who were gay or lesbian used roughly 4.5 days more than their heterosexual counterparts. Similarly, the estimate of hookah use frequency among gay or lesbian students (mean = 16.6, 95% CI, 8.3–24.9) was approximately 3 times the frequency among heterosexual students (mean = 5.8, 95% CI, 3.0–8.7). For the emerging heated tobacco products, heterosexual users reported using 7.6 days in the past 30 days, while the frequency among gay or lesbian and bisexual students was 15.0 and 5.0 days, respectively.

Table 3 presents the association between sexual identity and tobacco use frequency among current tobacco product users. After adjusting for

Table 3

Association between sexual identity and tobacco use frequency among current tobacco product users, 2020 National Youth Tobacco Survey.

	Gay or Lesbian	Bisexual	Not Sure
Cigarettes	1.17(0.81, 1.68)	1.39(1.06, 1.82)	0.78(0.55, 1.11)
Cigars	1.31(0.91, 1.88)	0.84(0.62, 1.14)	0.85(0.59, 1.24)
Chewing tobacco, snuff, or dip	1.45(0.79, 2.66)	0.77(0.40, 1.46)	0.78(0.39, 1.57)
Electronic cigarettes	1.45(1.19, 1.76)	0.93(0.81, 1.07)	0.82(0.67, 1.00)
Hookah	1.81(1.08, 3.03)	0.66(0.46, 0.95)	1.02(0.64, 1.62)
Heated tobacco products	1.28(0.75, 2.20)	0.71(0.47, 1.08)	1.15(0.72, 1.83)

¹Regression analyses were restricted to current users for each tobacco product (students who used the product at least one day during the past 30 days).

²Multivariable negative binomial regression models were performed to assess the association between sexual identity and tobacco use frequency, adjusting for grade, sex, race/ethnicity, exposure to tobacco marketing, and tobacco use by household members.

³Heterosexual (straight) students served as the reference group, and significant incidence rate ratios (p < 0.05) were presented in boldface.

covariates, the expected number of days using e-cigarettes in the past 30 days for gay or lesbian (Incidence Rate Ratio (IRR) 1.45, 95% CI, 1.19–1.76) was significantly higher compared to heterosexual (straight)

Table 2

Population estimates of mean tobacco use frequency among current product users by sexual identity, 2020 National Youth Tobacco Survey.

Tobacco products	General population	Heterosexual (straight)	Gay or Lesbian	Bisexual	Not Sure	p-value
Cigarettes	8.21(6.70, 9.72)	7.48(6.04, 8.93)	11.04(5.68, 16.41)	9.75(7.00, 12.50)	8.15(2.94, 13.37)	<0.01
Cigars	7.88(6.85, 8.91)	7.39(6.21, 8.58)	13.00(6.36, 19.65)	7.20(4.80, 9.60)	8.24(3.61, 12.86)	<0.0001
Chewing tobacco, snuff, or dip	10.72(9.26, 12.19)	11.02(9.39, 12.66)	12.41(4.33, 20.49)	5.31(0.46, 10.15)	13.28(3.84, 22.72)	0.01
Electronic cigarettes	13.13(12.24, 14.02)	13.02(12.12, 13.92)	17.51(14.18, 20.83)	12.54(9.84, 15.23)	11.83(8.73, 14.93)	<0.0001
Hookah	8.63(7.21, 10.06)	7.79(5.63, 9.95)	16.58(8.31, 24.85)	5.84(2.95, 8.73)	12.39(5.89, 18.89)	<0.0001
Heated tobacco products	7.79(5.92, 9.66)	7.59(5.09, 10.09)	15.03(9.33, 20.73)	4.95(2.14, 7.76)	10.48(5.53, 15.44)	<0.0001

¹ANOVA tests were used to detect significant differences among groups.

²Tobacco use frequency was defined as mean days using the product in the past 30 days.

³Weighted mean days using the product in the past 30 days and their 95% confidence interval was estimated for current users (students who used the product at least one day during the past 30 days) for each tobacco product.

students. Gay or lesbian students who were current hookah users on average reported 81% more days using a hookah (IRR 1.81, 95% CI, 1.08–3.03) compared to their heterosexual (straight) counterparts. Likewise, cigarette smoking frequency was significantly higher among bisexual cigarette smokers (IRR 1.39, 95% CI, 1.06–1.82). Among ever tobacco product users, similar results were found (Table 4). The expected number of days using an e-cigarette (IRR 1.49, 95% CI, 1.16–1.90) and hookah (IRR 2.27, 95% CI, 1.01–5.09) was significantly higher among gay or lesbian students compared to heterosexual (straight) students.

4. Discussion

This study examined the frequency of tobacco product use among sexual minority groups versus heterosexuals using a nationally representative sample of U.S. middle and high school students. Findings revealed that e-cigarettes are the most frequently used tobacco products. Current e-cigarettes users reported using roughly every other day, which is consistent with prior results that e-cigarette has become the most commonly used tobacco product in middle and high school students since 2014 (Wang et al., 2018; Gentzke et al., 2020). This study also found that sexual identity was significantly associated with the frequency of e-cigarettes and hookah use. On average, current tobacco product users (except chewing tobacco, snuff, or dip users) who were gay or lesbian used about 4 to 8 days more than their heterosexual counterparts. After adjusting covariates, lesbian or gay students were estimated to use e-cigarettes and hookah more frequently (45%–80% more days) than heterosexual students. Likewise, a higher frequency of cigarette smoking was found among bisexual current smokers than heterosexual current smokers. These findings are consistent with the existing literature examining disparities in substance use status (Azagba et al., 2019; Garcia et al., 2021; Dermody, 2018; Watson et al., 2018a, 2018b).

The elevated use of tobacco products among sexual minority populations is commonly attributed to the minority stress model (Ryan et al., 2001; Meyer, 2003; Goldbach et al., 2014). One meta-analysis showed that victimization, lack of supportive environments, psychological stress, and adverse disclosure reactions were among the leading risk factors for substance use among sexual minority youth (Goldbach et al., 2014). It is well established that sexual minority groups have a heightened risk of experiencing school-based victimization (Toomey and Russell, 2016), and recent evidence suggests a positive association

between bullying victimization status and e-cigarette use among students (Azagba et al., 2020; Hansen et al., 2021). The disproportionate tobacco use might also result from the tobacco industry's aggressive marketing campaigns aimed at sexual minority communities (Dilley et al., 2008; Sheahan and Garrity, 1992; Wills and Hirky, 1996; Smith et al., 2008). Simultaneously, the regulation of e-cigarettes is less strict in some jurisdictions.

Our study also documented that elevated risk of tobacco use varied among sexual minorities. We found that higher frequency of cigarette smoking among bisexual current smokers while no significant difference between gay or lesbian and heterosexual current smokers. Studies have shown that protective factors, especially social support from the minority community, have buffered the disparities (Baiocco et al., 2020; Price et al., 2020). However, levels of these protective factors varied both within and outside of sexual minority communities, with bisexual individuals reporting feeling socially isolated and marginalized (Price et al., 2020; Nagata et al., 2020; Felt et al., 2020). Previous studies have documented that peer influence is one of the strongest predictors of susceptibility to e-cigarettes and hookah use (Carey et al., 2018), and affiliation with substance-using peers was associated with increased substance use among sexual minorities over time, even after accounting for effects of minority stress (Dermody, 2018). The increased frequency of cigarette use among youth who were not sure of their sexual identity is also worth attention. Elsewhere, a study conducted in a large Midwestern county found that truancy, mental health problem, and substance use were more prevalent among youth questioning their sexual identity than either heterosexual or LGB students (Birkett et al., 2009). These results imply that youth who are unsure about their sexual identity may experience a heightened risk of negative outcomes than LGB youth and deserve focused research attention.

Conversely, we found no significant differences in other tobacco product use frequencies between sexual minority and heterosexual youth. One explanation could be that existing tobacco prevention and control strategies, including smoke-free policies and media campaign warnings, have raised the risk awareness of these products and potentially reduced the frequency of use disparities (National Center for Chronic Disease Prevention and Health Promotion (US), 2014; U.S. Department of Health and Human Services, 2012; Hatzenbuehler et al., 2014). Additionally, recent pro-LGBT social movements might have reduced the stress caused by structural stigmatization and discrimination (Meyer, 2003). For example, in 1988, more than 88% of Americans opposed granting same-sex couples the right to marry compared to roughly 60% in 2008 (Sherkat et al., 2011). Similarly, a study conducted among teachers using the 2006–2014 General Social Survey found that though many teachers had negative attitudes about homosexuality, the prevalence was reducing (Hall and Rodgers, 2019). The insignificant disparities of heated tobacco products use might be due to low awareness; however, such products were perceived as less addictive and less harmful among youth, requiring further attentions (Berg et al., 2021).

The current study has limitations that are worth noting. The NYTS is a school-based survey. Thus, our study is not generalizable to youth not attending schools, such as home-schooled adolescents or youth who have dropped out of school. It is possible that respondents may recall events inaccurately because of the self-reporting nature of the survey. Additionally, the “Not sure” response to the sexual identity question is potentially susceptible to misclassification error. The response could capture individuals who are unsure of their sexual identity, who do not fully understand the concept of sexual identity, and possibly other subgroups. Lastly, it is unclear to what extent lower school participation rate resulting from the early-ending 2020 NYTS data collection due to the COVID-19 pandemic may have impacted our findings. However, the survey weight adjustments included additional indicators from extended nonresponse analyses to minimize potential bias (Gentzke et al., 2020; Office on Smoking and Health, 2020). Even with the limitations, this study provides insight into differences in tobacco product use frequency among sexual minority populations and heterosexuals.

Table 4

Association between tobacco use frequency and sexual identity among lifetime tobacco product users, 2020 National Youth Tobacco Survey.

	Gay or Lesbian	Bisexual	Not Sure
Cigarettes	1.07(0.60, 1.91)	0.73(0.42, 1.28)	1.65(1.06, 2.56)
Cigars	1.62(0.93, 2.84)	0.73(0.44, 1.21)	0.78(0.49, 1.23)
Chewing tobacco, snuff, or dip	1.62(0.63, 4.13)	0.46(0.15, 1.40)	1.14(0.31, 4.21)
Electronic cigarettes	1.49(1.16, 1.90)	0.82(0.63, 1.06)	0.93(0.78, 1.11)
Hookah	2.27(1.01, 5.09)	1.03(0.51, 2.08)	0.57(0.33, 1.00)
Heated tobacco products	1.01(0.45, 2.23)	1.41(0.66, 3.00)	0.71(0.37, 1.36)

¹Regression analyses were restricted to lifetime users for each tobacco product (students who ever used the product).

²Multivariable zero-inflated negative binomial models were performed to assess the association between sexual identity and tobacco use frequency, adjusting for grade, sex, race/ethnicity, exposure to tobacco marketing, and tobacco use by household members.

³Heterosexual (straight) students served as the reference group, and significant incidence rate ratios ($p < 0.05$) were presented in boldface.

5. Conclusions

This study used a nationally representative sample of middle and high school students to examine the frequency of various tobacco product use in both sexual minority groups and heterosexuals. Findings indicate that sexual identity was strongly associated with tobacco use frequency, especially for e-cigarettes and hookah. Lesbian or gay students were estimated to use e-cigarettes and hookah more frequently than heterosexual students. We also found a higher frequency of cigarette smoking among current bisexual smokers. Elevated tobacco use among sexual minority groups deserves special consideration in order to reduce the tobacco use burden among a population group that is highly vulnerable to marketing and advertisement targeting.

Financial disclosure

None.

CRedit authorship contribution statement

Sunday Azagba: Conceptualization, Investigation, Methodology, Project administration, Resources, Supervision, Writing - review & editing. **Lingpeng Shan:** Formal analysis, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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