



Cigarette smoking, e-cigarette use, and sexual identity among high school students in the USA

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Abstract

Although tobacco use has decreased in the general population in recent years, smoking remains high among subpopulations. This study examined whether sexual identity is associated with cigarette smoking and e-cigarette use among high school students. Data were drawn from the US Youth Risk Behavior Surveillance System ($n = 28811$). We grouped participants according to sexual identity status. Propensity score matching technique was used to address covariate imbalance among sexual identity groups. Subgroup analyses were performed for male and female students. Of the four sexual identity groups analyzed in this study, bisexual adolescents had significantly higher odds of cigarette smoking (cigarette smoking, OR, 1.61; 95% CI, 1.24–2.08; cigarette smoking for ≥ 10 days, OR, 1.79; 95% CI, 1.28–2.51; cigarette smoking for ≥ 20 days, OR, 2.04; 95% CI, 1.38–3.03). Further, in a sex-based subgroup analysis, results showed significant differences, with bisexual females more likely to smoke cigarettes and use e-cigarettes for ≥ 20 days compared with heterosexual female adolescents.

Conclusions: Sexual identity status is strongly associated with cigarette smoking and e-cigarette use. Female bisexual adolescents have an increased risk of cigarette smoking and e-cigarette use for ≥ 20 days. While tobacco control policies have been effective in reducing cigarette use in the general population, targeting policy toward sexual minorities is an important consideration.

What is Known:

- Sexual minority groups face a disproportionate amount of stress and have a heightened risk of substance use.
- Methodological concerns exist in the extant literature, including limited data at the national level.

What is New:

- Propensity score matching was used to account for imbalances in sexual identity subgroups, and findings show significant heterogeneity in cigarette and e-cigarette use among sexual minority high school students.
- Sexual identity status is strongly associated with cigarette smoking and e-cigarette use, especially among bisexual identity female subgroup.

Keywords Minority groups · Sexual identity · Lesbian · Gay · Bisexual · Cigarette · E-cigarette

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Introduction

Tobacco use is the leading cause of preventable death worldwide, accounting for a significant number of deaths each year in the USA [1]. Tobacco use remains a significant public health problem and can lead to a variety of health consequences, including cancer, heart disease, and stroke [2–5]. There has been a considerable change in the tobacco market in the last decade with the introduction of electronic vaping products, including electronic cigarettes (e-cigarettes). E-cigarettes have become increasingly popular among adolescents. While the long-term health effects remain largely unknown, recent research has supported e-cigarettes as a potentially less toxic alternative to cigarette smoking [6, 7]. Though e-cigarettes are not risk-free, with evidence suggesting that

numerous toxicants can be found in both the solution and emissions [8], the relationship between e-cigarette use and traditional cigarette smoking remains inconclusive in the literature. A systematic review and meta-analysis of longitudinal studies found that e-cigarette use is associated with an elevated risk of future cigarette smoking [9], while other studies have found that e-cigarettes have been shown to reduce craving and withdrawal associated with abstaining from cigarettes [10–12].

The burden of tobacco use does not impact all populations equally; subpopulations such as sexual minority groups have higher rates of cigarette smoking among both adults [13–15] and adolescents [15–17]. Sexual minority populations have not seen the same improvement in reduction of cigarette smoking prevalence as the general population, with rates remaining notably high through recent years [15, 18]. Evidence suggests that the current rates of adult cigarette smoking are significantly higher in sexual minorities compared to heterosexuals [14, 19]. There is a large body of literature showing that sexual minority populations, such as lesbian, gay, bisexual, and gender minority individuals (LGBT), have higher rates of tobacco use compared to non-sexual minority, non-gender variant heterosexual populations [14, 15, 20–24]. Several mechanisms could explain the elevated risk of tobacco use among sexual minority populations, including the tobacco industry's aggressive marketing campaigns, which has targeted LGBT communities [25, 26]. Sexual minorities may face a disproportionate amount of daily stress [27] that stems from factors including prejudice and stigmatization, as described by the minority stress model [28]. Smoking is more prevalent among groups that experience greater levels of stress [29]. While e-cigarette use among subpopulations has been less studied, recent evidence suggests that the relationship between higher tobacco use and sexual minorities also applies to e-cigarette use among adults [14, 18]. However, few national studies have explored the use of alternative tobacco products among sexual identity subgroups in adolescent populations [30].

From a public health and prevention perspective, a greater understanding of the relationship between tobacco use and sexual identity will provide an opportunity to reduce the overall disease burden, especially in a subpopulation with a heightened risk of use. Historically, prior research has combined sexual minority subgroups such as gay, bisexual, and transgender into one group, potentially masking important differences between subgroups [31]. For example, recent research suggests that sexual minority female adults are disproportionately impacted by elevated cigarette and e-cigarette use [14, 32]. Among the general population, the prevalence of tobacco use is higher among males than females [22]; however, some research suggests that sexual minority females may have a higher risk of smoking than sexual minority males [33]. Studies that

have attempted to compare various subgroups may have unreliable results due to small sample sizes [34–36]. In addition, lacking from the extant literature are studies employing a rigorous study design that addresses potential imbalances between sexual minority subgroups and heterosexuals. In the current study, we used a propensity score matching (PSM) analytic approach to examine whether sexual identity is associated with cigarette smoking and e-cigarette use using a nationally representative sample of high school students in the USA. In non-experimental or observational studies, PSM is a powerful statistical approach that allows researchers to ensure that the distribution of observed characteristics is balanced between treatment and control groups when estimating treatment effects. The goal of PSM is to mimic experimental design by eliminating selection or confounding bias resulting from differences in observable characteristics between the treatment (exposure) and control groups.

Methods

Data source

We obtained data from the Youth Risk Behavior Surveillance System (YRBSS) collected by the Centers for Disease Control and Prevention. The YRBSS was developed in 1990 to gather health and health behavior information among 9th- to 12th-grade students in public and private schools in the USA. YRBSS was designed to monitor health behaviors that contribute to the leading causes of death, disability, and social problems among adolescents and adults, including behaviors that contribute to unintentional injuries and violence, tobacco use, alcohol and other drug use, unhealthy dietary behaviors, inadequate physical activity, and sexual behaviors related to unintended pregnancy and sexually transmitted infections. A sexual identity question was added for the first time to the national questionnaire in 2015 [37].

Study cohorts

In order to address the relationship between risk of cigarette and e-cigarette use and sexual orientation, we identified our study cohort as all national survey participants in 2015 and 2017. In 2015, 125 of 180 sampled schools from 50 states and the District of Columbia participated, resulting in a total of 15624 students. Similarly, 144 of 192 sampled schools participated in 2017, with a total of 14765 students. The overall response rates were 60% for both years. In our study, we included all 30,389 students. A total of 28,811 students who answered the sexual identity question were included in the post-match sample for the final analyses.

Measures

Outcome variables

Three dichotomous variables were created to represent levels of cigarette smoking in the 30 days prior to the survey: (i) “Cigarette smoking,” which referred to any cigarette use in the past 30 days prior to the survey (smoked at least once); (ii) “Cigarette smoking ≥ 10 days,” which referred to smoking at least 10 days out of the past 30 days (smoked at least 10 days); (iii) “Cigarette smoking ≥ 20 days,” which referred to smoking at least 20 days out of the past 30 days (smoked at least 20 days). The latter two definitions were used in order to capture more frequent use. These three dichotomous variables were similarly created for e-cigarette use.

Independent variables

The primary variable of interest, sexual identity, was assessed from the national YRBSS using the question “Which of the following best describes you” with response options including “Heterosexual (straight),” “Gay or lesbian,” “Bisexual,” and “Not sure.” Each of the response options was created as a category in order to avoid masking important differences among sexual minority adolescents. To increase our sample size for sufficient power, data from the 2015 and 2017 YRBSS were used. We also included students’ demographic information (i.e., age, sex, race, alcohol consumption, marijuana use, and suicide attempts) in the analysis. The majority of the 9th- to 12th-grade adolescents included was between 12 and 18 years of age; we therefore treated age as a continuous variable. The sex variable was determined from the answer to the question “What is your sex?” We used the calculated race/ethnicity variable from YRBSS, and further grouped the options of American Indian/Alaska Native, Asian, Native Hawaiian/other Pacific Islander, Multiple–Hispanic, and Multiple–Non-Hispanic into an “Other” category. Alcohol drinking and marijuana use were defined by whether students used at least once in the 30 days prior to taking the survey. Attempting suicide was defined by whether the students attempted suicide at least once during the 12 months before the survey.

Statistical analysis

Demographic characteristics were described by the sexual identity groups (Heterosexual (straight), Gay or lesbian, Bisexual, and Not sure). Continuous variables were reported using the mean and 95% confidence interval, whereas categorical variables were reported with frequency and percentage. Descriptive statistics, *t* tests, and Wald chi-square tests were used for comparing characteristics among the four groups.

Propensity score model PSM is a powerful statistical approach that allows researchers to ensure that the distribution of observed characteristics is balanced between treatment and control groups when estimating treatment effects [38]. The goal of PSM is to mimic experimental design by making the comparability of study groups (sexual minority subpopulations and heterosexuals) on observed characteristics as similar as possible, thereby minimizing selection bias in observational studies [38]. For the PSM analysis, we used a flexible approach, generalized boosted model (GBM), to estimate propensity score weights for multiple treatments [39, 40]. Recent advances in PSM have shown that machine learning methods (e.g., GBM) perform better than parametric approaches in terms of bias reduction and mean squared error (e.g., logistic regression for a binary case and multinomial logistic regression for multiple treatments) [39, 40]. We used the algorithm developed by McCaffrey et al. [39] for multinomial propensity scores function in the Toolkit for Weighting and Analysis of Nonequivalent Groups (twang) package [39, 41]. Twang package uses GBM in estimating propensity score weights. It relies on an iterative process of fitting regression trees, whereby at each subsequent iteration a new tree is selected to provide the best fit to the residuals of the model from the prior iteration [41]. Students’ characteristics including age, sex, race, alcohol consumption, marijuana use, and attempting suicide were included in the model estimating propensity score weights. Additionally, we performed a sensitivity analysis excluding marijuana and alcohol. To account for the complex survey design, we used the sampling weights in the PSM analysis and used the sampling weight multiplied by the propensity score weight as the final propensity score weight in the outcome analyses. As shown in prior simulation studies, this strategy allowed us to produce better population-level treatment effects estimates [41, 42].

Diagnostic checks We assessed a key assumption required for valid estimates to be obtained from PSM (overlap assumption), which states that each individual has a positive probability of receiving each treatment. Boxplots were used to compare the distribution of propensity scores across groups in order to assess the overlap assumption. In addition, an imbalance test was performed to check whether there was a balance between groups by comparing absolute standardized mean differences (ASMD) between the treatment groups on the observed characteristics, before and after weighting [39]. After weighting, the ASMD should significantly decrease if sufficient balance is achieved [39].

Outcome model After deriving the weights from the PSM analysis, we examined the association between sexual identity and cigarette/e-cigarette use. Each outcome was regressed on categorical variables representing sexual identity status with heterosexual being the reference group. Separate subgroup

analyses were performed for male and female students. The analysis used the derived combined weight in the outcome analysis (sampling weight multiplied by the propensity score weight) [41, 42]. All of the statistical analyses were performed using SAS 9.4 (SAS Institute, Inc. Cary, NC).

Results

Among the 28811 students included in the study, 24966 (82.15%) identified as heterosexual (straight), 681 (2.22%) identified as gay or lesbian, 2059 (6.78%) identified as bisexual, and the remaining 1105 (3.64%) were not sure about their sexual identity. The distribution of demographic characteristics and various substance use according to sexual identity status is listed in Table 1. Sexual minority adolescents were more likely to be female (53.44% for gay or lesbian, 81.38% for bisexual, and 60.85% for not sure) compared to heterosexual adolescents (47.73%). The racial distributions were significantly different among sexual identity groups. The gay or lesbian identity had the highest percentage of those who identified as black (21.53%) compared to other sexual identity groups. Bisexual had the highest rate for alcohol drinking (62.12%) and attempting suicide (35.75%) compared to all other sexual identity groups.

Figure 1, which shows the empirical propensity score distributions, indicates that the overlap assumption was met in our study. Supplementary Table 1 presents the characteristics of the study participants in both pre-match and post-match samples using simple chi-square tests for a categorical variable and *t* test for a continuous variable. Prior to matching, statistically significant differences were observed in all the variables. Overall, there were no statistically significant differences in the students' characteristics after propensity score weighting. The absolute standardized mean differences between the treatment groups on the observed characteristics, before and after weighting are shown in Table 2. The ASMD significantly decreased for all the covariates. The distribution of the propensity scores across groups also confirms there was a balance between groups after weighting.

Table 3 presents the results of logistic regression of cigarette and e-cigarette use on sexual identity status. Sexual minority groups (gay or lesbian, bisexual, and not sure) had higher odds of cigarette smoking. However, only the bisexual group had significantly higher odds for all the cigarette smoking measures (cigarette smoking, OR, 1.61; 95% CI, 1.24–2.08; cigarette smoking for ≥ 10 days, OR, 1.79; 95% CI, 1.28–2.51; cigarette smoking ≥ 20 days, OR, 2.04; 95% CI, 1.38–3.03). The not sure group had significantly higher odds of smoking at least 20 days out of the last 30 days (OR, 2.00; 95% CI, 1.10–3.64) and lower odds of e-cigarette use

(OR, 0.60; 95% CI, 0.38–0.94). No significant association was found between sexual identity status and e-cigarette use except for the not sure group.

In the sex-based subgroup analyses (Table 4), we found that bisexual males had significantly higher odds of cigarette smoking ≥ 20 days (OR, 2.31; 95% CI, 1.21–4.24) when compared to heterosexual/straight male adolescents. Among females, bisexuals had significantly higher odds of any cigarette smoking (OR, 1.94; 95% CI, 1.50–2.50), cigarette smoking ≥ 10 days (OR, 1.84; 95% CI, 1.32–2.58), cigarette smoking ≥ 20 days (OR, 1.78; 95% CI, 1.22–2.58). Additionally, female bisexuals had significantly higher odds for e-cigarette use ≥ 10 days (OR, 1.96; 95% CI, 1.38–2.80) and e-cigarette use ≥ 20 days (OR, 2.44; 95% CI, 1.47–4.05) when compared to heterosexual/straight female adolescents. We also found lesbian adolescents had higher odds of e-cigarette use ≥ 20 days (OR, 2.25; 95% CI, 1.01–4.99) compared to heterosexual/straight female adolescents. Sensitivity analyses were performed for both the full sample and the sex-based subgroups excluding marijuana and alcohol as covariates, results were largely similar (Supplementary Tables 2 and 3).

Discussion

Cigarette smoking remains a public health issue among sexual minority adolescents in the USA [15–17], while the increasing use of e-cigarettes presents another area of potential importance. Considering that e-cigarette marketing ads are increasingly reaching adolescents [43], and that sexual minority populations have higher rates of tobacco use, there is a need for research concerning cigarette and e-cigarette use among sexual minority adolescents. Findings may have policy implications and recommendations for regulation of e-cigarettes such as marketing restrictions and flavoring bans, particularly aimed at at-risk populations [44].

Our study addresses a gap in the literature by examining cigarette smoking and e-cigarette use among sexual identity subgroups using data from a nationally representative survey of high school students. Previous research has shown a relationship between sexual minority adolescents, particularly lesbian and bisexual females, and cigarette smoking and e-cigarette use [30]. However, the majority of prior research has mainly used small samples (regional data) [34–36] and has not rigorously assessed the potential imbalance on the observed characteristics of sexual minority subpopulations and heterosexuals. We addressed these gaps in the extant literature by using a large sample size and PSM approach.

Table 1 Summary statistics of study participants, 2015 and 2017

	Heterosexual (straight)		Gay or lesbian		Bisexual		Not sure	
<i>N</i>	24966		681		2059		1105	
Age	16.27 (16.26–16.29)		16.32 (16.20–16.43)		16.17 (16.11–16.24)		16.11 (16.02–16.20)	
Sex								
Male	12974	52.27%	311	46.56%	377	18.62%	426	39.15%
Female	11846	47.73%	357	53.44%	1648	81.38%	662	60.85%
Race								
White	10876	44.43%	253	38.63%	863	43.04%	443	41.71%
Black	3535	14.44%	141	21.53%	356	17.76%	159	14.97%
Hispanic	3349	13.68%	71	10.84%	205	10.22%	125	11.77%
Others	6719	27.45%	190	29.01%	581	28.98%	335	31.54%
Alcohol use								
Yes	10512	45.40%	314	55.87%	1161	62.12%	442	44.42%
No	12642	54.60%	248	44.13%	708	37.88%	553	55.58%
Marijuana use								
Yes	4905	19.92%	187	29.97%	641	32.16%	230	21.74%
No	19720	80.08%	437	70.03%	1352	67.84%	828	78.26%
Attempting suicide								
Yes	2427	11.24%	143	25.81%	632	35.75%	239	26.38%
No	19157	88.76%	411	74.19%	1136	64.25%	667	73.62%
Cigarette smoking								
Yes	1680	6.95%	106	16.83%	310	15.68%	124	12.05%
No	22508	93.05%	524	83.17%	1667	84.32%	905	87.95%
Days smoking cigarettes								
< 10	23514	96.77%	575	93.80%	1818	92.33%	971	93.28%
≥ 10	784	3.23%	38	6.20%	151	7.67%	70	6.72%
Days smoking e-cigarettes								
< 20	23733	97.67%	585	95.43%	1853	94.11%	985	94.62%
≥ 20	565	2.33%	28	4.57%	116	5.89%	56	5.38%
E-cigarette use								
Yes	1435	12.56%	63	18.92%	169	15.41%	69	12.04%
No	9992	87.44%	270	81.08%	928	84.59%	504	87.96%
Days using e-cigarettes								
< 10	22152	95.00%	574	94.10%	1725	92.79%	946	93.29%
≥ 10	1166	5.00%	36	5.90%	134	7.21%	68	6.71%
Days using e-cigarettes								
< 20	22612	96.97%	583	95.57%	1779	95.70%	965	95.17%
≥ 20	706	3.03%	27	4.43%	80	4.30%	49	4.83%

¹ Continuous variables are presented as unweighted mean (95% confident interval)

² Categorical variable are presented as unweighted frequency and percentage

We found that of the four sexual identity groups, bisexual adolescents had significantly higher odds of cigarette smoking for all the cigarette smoking measures analyzed. Further, in a sex-based subgroup analysis, results showed substantial differences with lesbians having significantly higher odds of cigarette smoking and e-cigarette use ≥ 20 days compared with heterosexual

female adolescents. These results suggest that female sexual minority adolescents are particularly inclined toward cigarette and e-cigarette use. These findings augment previous research that has shown a relationship between lesbian and bisexual female adolescents and e-cigarette use [30]. Our findings further confirm the need for separate analysis by gender.

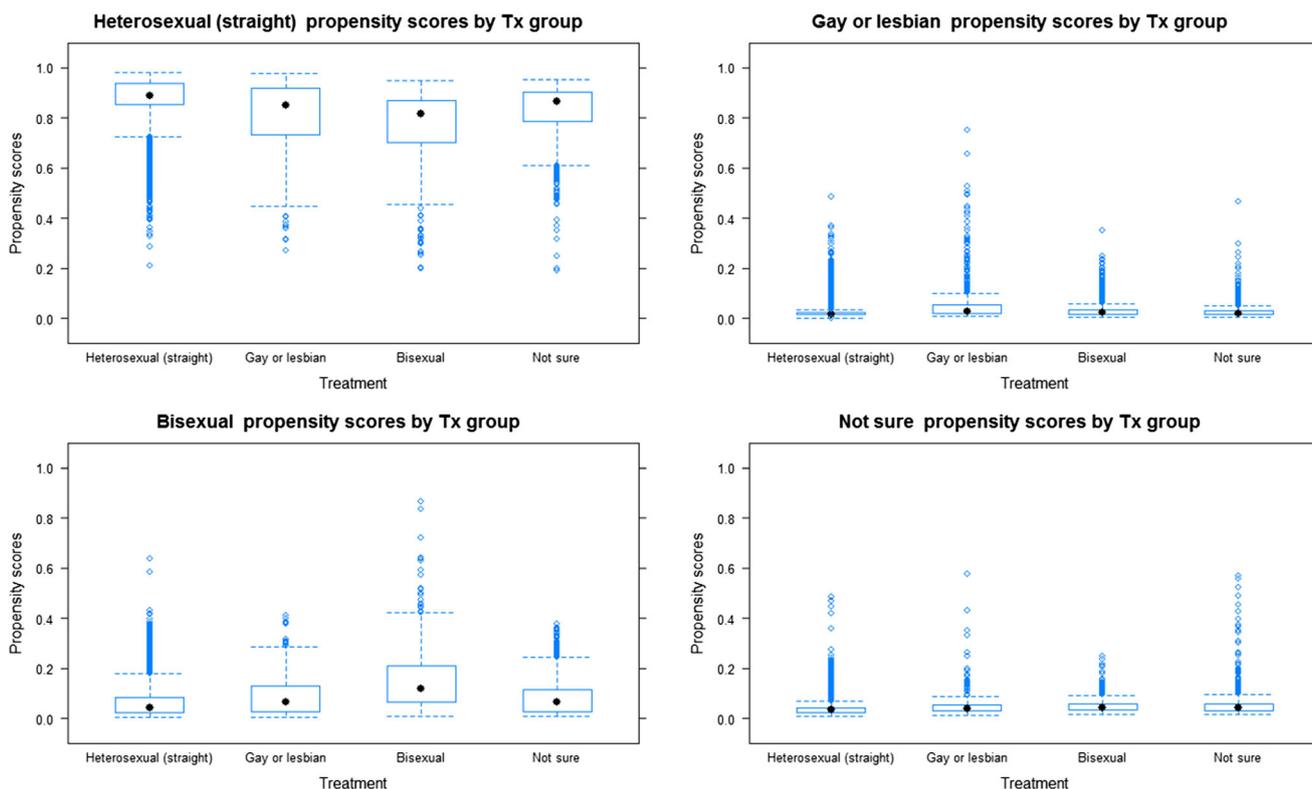


Fig. 1 Graphical assessment of overlap assumption using boxplots of the estimated propensity distribution scores by sexual identity status

There are several possible explanations for the increased use of cigarettes in sexual minority populations. The minority stress model recognizes that sexual minorities may experience prejudice, fear of rejection, homophobia, and coping processes that could contribute to their heightened stress levels [28]. Smoking is more prevalent among groups that experience higher levels of stress, perhaps as a potential a coping mechanism [29]. Another possible explanation includes the

aggressive marketing ads that tobacco companies have aimed at sexual minority populations [45, 46]. Research has found these campaigns to be effective in sexual minority communities, particularly among lesbian and bisexual women who were found to experience more marketing exposure and be more receptive to the marketing when compared with heterosexual women [45]. This extends to social media, as sexual minority smokers are more likely to interact with tobacco-

Table 2 Pre- and post-propensity weighted means for covariates and absolute standardized mean difference (ASMD)

	Propensity score mean (unweighted) (ASMD from heterosexual (straight))				Propensity score mean (weighted) (ASMD from heterosexual (straight))			
	Heterosexual (straight)	Gay or lesbian	Bisexual	Not sure	Heterosexual (straight)	Gay or lesbian	Bisexual	Not sure
Age	16.27	16.32 (0.03)	16.17 (0.07)	16.11 (0.11)	16.27	16.32 (0.04)	16.26 (0.01)	16.23 (0.03)
Sex	0.47	0.52 (0.46)	0.18 (0.74)	0.39 (0.30)	0.50	0.51 (0.01)	0.52 (0.04)	0.53 (0.05)
Race	0.02	0.04 (0.11)	0.03 (0.04)	0.04 (0.11)	0.02	.02 (0.02)	0.02 (0.02)	0.02 (0.01)
Alcohol use	0.51	0.36 (0.29)	0.34 (0.33)	0.50 (0.01)	0.43	0.44 (0.01)	0.46 (0.06)	0.51 (0.04)
Marijuana use	0.79	0.64 (0.32)	0.66 (0.29)	0.75 (0.09)	0.78	0.79 (0.02)	0.78 (0.01)	0.79 (0.02)
Attempting suicide	0.77	0.60 (0.33)	0.55 (0.44)	0.60 (0.33)	0.74	0.74 (0.01)	0.74 (0.01)	0.74 (0.02)

ASMDs are between heterosexual (straight) and other sexual minority groups

Table 3 Logistic regression of cigarette smoking and e-cigarette use on sexual identity status

	Gay or lesbian	Bisexual	Not sure	Heterosexual (straight)
Cigarette smoking	1.21 (0.84, 1.73)	1.61 (1.24, 2.08)	1.17 (0.87, 1.58)	Ref
Cigarette smoking ≥ 10 days	1.24 (0.75, 2.05)	1.79 (1.28, 2.51)	1.70 (0.99, 2.89)	Ref
Cigarette smoking ≥ 20 days	1.16 (0.65, 2.09)	2.04 (1.38, 3.03)	2.00 (1.10, 3.64)	Ref
E-cigarette use	0.75 (0.49, 1.16)	0.95 (0.67, 1.35)	0.60 (0.38, 0.94)	Ref
E-cigarette use ≥ 10 days	0.70 (0.43, 1.12)	1.03 (0.73, 1.45)	0.75 (0.49, 1.14)	Ref
E-cigarette use ≥ 20 days	0.97 (0.57, 1.67)	1.24 (0.83, 1.86)	0.74 (0.45, 1.22)	Ref

Ref represents the reference category

related marketing, including e-cigarette messages, on certain platforms [47].

This study is subject to a few limitations. YRBSS data are collected through school-based surveys, consequently excluding adolescents not enrolled in school such as home-schooled students and high school dropouts, which could be more prominent for sexual minority adolescents because they are more likely to drop out and have worse school attendance than their non-sexual minority peers [30]. Another limitation of the present study is the sexual identity question used from the survey, which allowed students the option to select “Not sure.” This response could capture more than one category of adolescents: those who are unsure of their sexual identity, those who identify as something other than the listed options, those who do not fully understand the meaning of sexual identity, and possibly other subgroups as well. Also, the survey only provided answer options regarding sex assigned at birth, overlooking certain gender minority adolescents, including students who are non-binary or

transgender. Lastly, the PSM approach can only address selection based on observed characteristics.

Conclusion

Using a nationally representative sample of high school students and rigorous analytical method, we found that of the four sexual identity groups analyzed in the current study, bisexual adolescents had significantly higher odds of cigarette smoking. Bisexual females had higher odds of both cigarette smoking and e-cigarette use compared to their heterosexual peers. We also found that gay male adolescents had significantly lower odds of e-cigarette use for ≥ 10 days when compared to straight male adolescents. While tobacco control policies have been effective in reducing cigarette use in the general population, it is important to consider targeting policy toward sexual minorities, as they have shown to be a group with heightened risk.

Table 4 Logistic regression of cigarette smoking and e-cigarette use on sexual identity status by sex

	Male				Female			
	Gay	Bisexual	Not sure	Heterosexual (straight)	Lesbian	Bisexual	Not sure	Heterosexual (straight)
Cigarette smoking	0.88 (0.54, 1.43)	1.38 (0.87, 2.20)	0.79 (0.50, 1.24)	Ref	1.75 (1.03, 1.31)	1.94 (1.50, 2.50)	1.68 (1.06, 2.65)	Ref
Cigarette smoking ≥ 10 days	1.27 (0.64, 2.52)	1.75 (0.96, 3.19)	1.90 (0.81, 4.48)	Ref	1.19 (0.56, 2.54)	1.84 (1.32, 2.58)	1.44 (0.70, 2.98)	Ref
Cigarette smoking ≥ 20 days	1.05 (0.49, 2.26)	2.31 (1.21, 4.24)	2.49 (0.99, 6.25)	Ref	1.30 (0.53, 3.21)	1.78 (1.22, 2.58)	1.45 (0.62, 3.39)	Ref
E-cigarette use	0.61 (0.29, 1.27)	0.85 (0.45, 1.60)	0.32 (0.17, 0.60)	Ref	0.99 (0.55, 1.80)	1.15 (0.81, 1.64)	1.00 (0.53, 1.89)	Ref
E-cigarette use ≥ 10 days	0.58 (0.23, 1.01)	0.65 (0.34, 1.26)	0.67 (0.40, 1.13)	Ref	1.25 (0.63, 2.48)	1.96 (1.38, 2.80)	0.91 (0.43, 1.94)	Ref
E-cigarette use ≥ 20 days	0.59 (0.25, 1.39)	0.88 (0.43, 1.82)	0.58 (0.32, 1.05)	Ref	2.25 (1.01, 4.99)	2.44 (1.47, 4.05)	1.14 (0.41, 3.21)	Ref

Ref represents the reference category

Authors' contributions SA conceptualized and designed the study, supervised all aspects of the study, contributed to the drafting of the manuscript, critically reviewed the manuscript, and approved the final manuscript as submitted. KL contributed to the drafting of the manuscript, critically reviewed the manuscript, and approved the final manuscript as submitted. LS conducted the data analysis, contributed to the drafting of the manuscript, critically reviewed the manuscript, and approved the final manuscript as submitted.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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