



Cigarette smoking behaviors and nicotine dependence at the intersection of sexual identity and sex in the United States: Findings from the National Survey on Drug Use and Health

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ABSTRACT

Introduction: Cigarette smoking is disproportionately high among lesbian, gay, and bisexual (LGB) adults. Yet, collapsing these identities into a monolith can disguise important within group disparities (e.g., lesbian/gay versus bisexual female). The purpose of this study is to report recent national prevalence estimates and trends of cigarette smoking behaviors and nicotine dependence by sexual identity and sex. **Methods:** Data were from the 2015–2019 National Survey on Drug Use and Health (n = 210,392; adults 18+), a nationally representative, repeated cross-sectional study of substance use and mental health in the U.S. We examined bivariate and multivariable associations between sexual identity and cigarette smoking measures (i.e., former smoking, lifetime smoking, current smoking, current daily smoking, nicotine dependence) by sex. We also examined linear time trends in current and former smoking. Covariates included age, race/ethnicity, education, annual household income, and survey year. **Results:** Bisexual women had the highest unadjusted prevalence of current smoking (31 %) and lowest of former smoking (25 %). LGB females and males had higher adjusted prevalence of current smoking, daily smoking, and nicotine dependence than heterosexual adults. Bisexual females and gay and bisexual males had lower adjusted prevalence of former smoking (adjusted prevalence ratio range: 0.78–0.85) than heterosexual counterparts. **Discussion:** This is the first study to identify disproportionately low prevalence of former smoking among bisexual females. Paired with findings of high prevalence of current cigarette smoking and nicotine dependence, these data suggest that tobacco control interventions targeted toward bisexual females are urgently needed to reduce the burden of cigarette smoking among these individuals.

1. Introduction

Despite population-level declines in cigarette use, smoking prevalence has remained stagnant among lesbian, gay, and bisexual (LGB) individuals over the past 30-years (Li et al., 2021). Smoking disparities also exist within LGB populations, based on sex and sexual identity, with higher current cigarette smoking prevalence for LGB females compared with heterosexual females, but minimal differences between gay/bisexual and heterosexual males (Li et al., 2021; Schuler and Collins, 2020; Fallin et al., 2015). Some studies have shown notable differences

between subgroups of LGB individuals (e.g., gay/lesbian vs. bisexual), with bisexual individuals reporting the highest rates of smoking (Schuler and Collins, 2020; Delahanty et al., 2019).

A handful of studies have reported associations between sexual identity and nicotine dependence, and tobacco use disorder (TUD) by sex. One study did not identify differences between LGB males and females who smoked compared with heterosexual males and females (Fallin et al., 2015), while the remaining studies found that gay/lesbian and bisexual females reported higher odds of nicotine dependence, compared to heterosexual females (Schuler and Collins, 2020; Corliss

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et al., 2013; McCabe et al., 2021; McCabe et al., 2019). Two studies found differences among males, with gay or bisexual males reporting higher odds of nicotine dependence, compared with heterosexual males (Schuler and Collins, 2020; McCabe et al., 2021).

Similarly, few studies have addressed cessation-related intentions and behaviors in LGB adults, with the only national, population-based study reporting no differences in desire to quit smoking and past quit attempts between LGB males or females and their heterosexual counterparts (Fallin et al., 2015). A study of adults who smoke in Ohio found that quit rates were similar for LGB and heterosexual adults (Patterson et al., 2021). Since Fallin et al. published data from 2009/2010, there have been no published national studies of cessation behaviors that stratify sexual identity by sex and separate lesbian/gay and bisexual respondents. Within the context of a growing population of LGB-identifying adults in the U.S. (Jones, 2022), this study provides recent national estimates of differences in past month cigarette use, daily cigarette smoking, former smoking, and nicotine dependence among LGB and heterosexual males and females using data from the National Survey on Drug Use and Health (NSDUH).

2. Material and methods

2.1. Data source

Data were from NSDUH, an annual survey providing health information on the civilian, noninstitutionalized US population aged 12 and older. NSDUH uses computer assisted interviewing (CAI) methods. Data were limited to adults 18+ and years 2015–2019 ($n = 210,392$) as sexual identity was not asked of those under 18 or prior to 2015 (Center for Behavioral Health Statistics and Quality, 2016). Additionally, NSDUH cautions against comparing data collected after 2019 with data collected beforehand due to methodological changes caused by COVID-19 (Center for Behavioral Health Statistics and Quality, 2021). This secondary analysis of deidentified, publicly available data received a non-human subjects determination from the Rutgers Institutional Review Board (IRB).

2.2. Measures

Participants were categorized by sexual identity based on their response to the following question: “Which one of the following do you consider yourself to be?” Response options were: 1) “Heterosexual, that is, straight,” 2) “Lesbian or Gay,” and 3) “Bisexual.” The NSDUH questionnaire indicates that the interviewer should “record respondent’s gender,” with answer choices including “male” or “female.”

Lifetime smoking was defined as smoking at least 100 cigarettes in one’s lifetime. Current smoking was defined as reporting lifetime smoking and indicating smoking at least one cigarette in the past 30 days; daily smoking was defined as reporting lifetime smoking and smoking cigarettes daily in the past month. Respondents were categorized as former smoking if they indicated lifetime smoking but did not smoke cigarettes in the previous year. A derived variable using the Fagerström Test of Nicotine Dependence was used to assess nicotine dependence (Heatherton et al., 1991); those who reported smoking within 30 min of waking were categorized as nicotine dependent (denominator was the entire sample).

2.3. Statistical analysis

Analyses were completed using Stata Version 17 (Stata/MP 17.0 MP for Windows). Taylor series estimation produced accurate standard errors, and survey weights accounted for complex survey design. List-wise deletion was used to remove missing, refused, and I don’t know responses (range = 0 %–1.9 %). Prevalence estimates presented follow NSDUH suppression guidelines (Center for Behavioral Health Statistics and Quality, 2021). Data were analyzed in 2022.

Descriptive statistics were assessed for all sociodemographic variables with chi-square tests to examine differences in distribution. Using pooled data, the prevalence of past-month and daily cigarette smoking, former smoking, and nicotine dependence were estimated by sexual identity and sex. Multivariable modified Poisson regression models explored associations between each smoking status variable and sexual identity by sex, controlling for age, race/ethnicity, education, income, and year, generating an adjusted prevalence ratio (aPR) for each sexual identity by sex. The robust Poisson regression method adjusts for over-inflation of the odds ratio when the sample prevalence of each of the outcomes is greater than 10 % (Barros and Hirakata, 2003). The prevalence of past-month and former cigarette smoking by sexual identity and sex were estimated for each year from 2015 to 2019. Modified Poisson regression models with sexual identity as the exposure of interest were used to evaluate linear time trends in past-month smoking and former smoking. An interaction between sexual identity and year was included to explore whether time trends depended on sexual orientation and sex.

3. Results

A total of 1.9 % and 3.1 % of adults identified as gay/lesbian and bisexual, respectively. Compared with heterosexual respondents, gay/lesbian respondents were more likely to be male, younger, identify as non-Hispanic Black, and report higher levels of education; bisexual respondents were more likely to be female, younger, and identify as Hispanic or of another race (Table 1).

3.1. Female respondents

Pooled data indicate gay/lesbian females had a higher prevalence of lifetime smoking (48.1 % vs 33.7 %), current smoking (26.3 % vs 15.2 %), past-month daily smoking (16.2 % vs 10.3 %), and nicotine dependence (13.1 % vs. 8.2 %) than heterosexual females. Gay/lesbian females also reported a lower prevalence of former smoking (39.7 % vs. 49.9 %), compared with heterosexual females. Bisexual females had a higher prevalence of lifetime smoking (44.9 % vs 33.7 %), current smoking (29.9 % vs 15.2 %), past-month daily smoking (18.7 % vs 10.3 %), and nicotine dependence (15.2 % vs. 8.2 %), and a lower prevalence of former smoking (25.1 % vs. 49.9 %) than heterosexual females (Table 2).

The overall prevalence of current smoking among females decreased between 2015 and 2019 ($p < 0.001$). There was no interaction between sexual identity and year, and the prevalence of smoking among both gay/lesbian and bisexual females remained higher than heterosexual females throughout. The overall prevalence of former smoking increased for females from 2015 to 2019 ($p < 0.05$). There was no interaction between sexual identity and year, and the prevalence of former smoking for bisexual but not gay/lesbian females remained lower than heterosexual females throughout (Fig. 1).

After adjusting for covariates, pooled data indicated gay/lesbian females had a higher prevalence of current smoking (adjusted prevalence ratio [aPR] = 1.64; 95 % confidence interval [CI] 1.48, 1.84), daily smoking (aPR = 1.55; 95 % CI 1.37, 1.76), and nicotine dependence (aPR = 1.55; 95 % CI 1.33, 2.80) compared to heterosexual females. Bisexual females had higher prevalence of current smoking (aPR = 1.65; 95 % CI 1.56, 1.74), daily smoking (aPR = 1.57; 95 % CI 1.46, 1.69), and nicotine dependence (aPR = 1.62; 95 % CI 1.50, 1.75) compared to heterosexual females. Bisexual females also had lower prevalence of former smoking (aPR = 0.85; 95 % CI 0.77, 0.93) compared to heterosexual females (Fig. 2).

3.2. Male respondents

Pooled data indicate gay males had a higher prevalence of nicotine dependence (12.3 % vs. 10.3 %) and a lower prevalence of former

Table 1
Study Population Characteristics. Data are combined from the 2015–2019 National Surveys on Drug Use and Health, US adults ages 18 and older.

Characteristic	Heterosexual (n ^a = 195,385) % ^b (95 % CI)	Gay / Lesbian (n ^a = 4,640) % ^b (95 % CI)	Bisexual (n ^a = 10,367) % ^b (95 % CI)
Overall	95.0 (94.8, 95.1)	1.9 (1.8, 2.0)	3.1 (3.0, 3.2)
Sex			
Male	49.0 (48.6, 49.3)	56.0 (53.3, 58.6)	28.8 (27.4, 30.2)
Female	51.0 (50.7, 51.4)	44.0 (41.4, 46.7)	71.2 (69.8, 72.6)
Age group			
18–25	13.0 (12.9, 13.2)	20.1 (18.9, 21.3)	37.3 (36.2, 38.5)
26–34	15.4 (15.2, 15.7)	22.3 (20.4, 24.3)	27.2 (26.0, 28.3)
35–49	24.8 (24.5, 25.1)	22.7 (21.1, 24.3)	19.8 (18.6, 21.0)
50+	46.7 (46.3, 47.2)	35.0 (32.6, 37.5)	15.7 (14.1, 17.5)
Race/ethnicity			
Hispanic	15.7 (15.3, 16.1)	17.5 (16.0, 19.1)	17.3 (16.3, 18.3)
Non, Hispanic (NH)	64.6 (64.1, 65.2)	62.2 (60.4, 64.0)	60.5 (59.3, 61.7)
White	11.8 (11.4, 12.1)	13.3 (12.3, 14.3)	12.7 (11.9, 13.7)
NH Black	7.9 (7.7, 8.1)	7.1 (6.1, 8.2)	9.5 (8.5, 10.6)
Other ^c			
Education completed			
Less than High School	12.4 (12.1, 12.7)	8.8 (7.8, 9.9)	12.6 (11.5, 13.7)
High school diploma/ GED	24.9 (24.6, 25.2)	18.4 (16.7, 20.1)	25.6 (24.4, 26.9)
Some college / Associate degree	30.9 (30.5, 31.2)	32.0 (30.2, 33.9)	36.7 (35.3, 38.0)
Bachelor's degree or more	31.8 (31.3, 32.3)	40.8 (38.7, 43.0)	25.1 (23.7, 26.6)
Annual household income (\$)			
<20,000	15.7 (15.4, 16.0)	20.0 (18.3, 21.8)	25.2 (23.9, 26.5)
20,000, 49,999	29.2 (28.8, 29.6)	29.2 (27.2, 31.2)	33.6 (32.4, 34.9)
50,000, 74,999	16.1 (15.8, 16.4)	15.7 (14.0, 17.5)	14.3 (13.4, 15.3)
>=75,000	39.0 (38.5, 39.6)	35.2 (33.1, 37.3)	26.9 (25.5, 28.3)

Note. ^a Number reflects the unweighted sample size.

^b Percentages are weighted.

^c Native American/Alaskan Native, Hawaiian/Pacific Islander, Asian, more than one race.

CI = confidence interval; GED = General Educational Development.

smoking (36.9 % vs 48.8 %) compared with heterosexual males, but prevalence of lifetime smoking (42.6 % vs. 44.6 %), past-month smoking (23.0 % vs. 20.3 %), and daily smoking (14.4 % vs 12.3) were similar for gay and heterosexual males. Bisexual males had a higher prevalence of current smoking (23.8 % vs 20.3 %) and nicotine dependence (12.1 % vs. 10.3 %), a similar prevalence of lifetime smoking (41.2 % vs. 44.6 %) and daily smoking (13.4 % vs 12.3 %), and a lower prevalence of former smoking (32.4 % vs 48.8 %), compared with heterosexual males. The overall prevalence of current smoking among males decreased ($p < 0.001$), and the overall prevalence of former smoking increased ($p < 0.05$) over time for males. There was no interaction between sexual identity and year for either current or former smoking (Fig. 1).

After adjusting for covariates, gay males had a higher prevalence of current smoking (aPR = 1.27; 95 % CI 1.14, 1.41), daily smoking (aPR = 1.41; 95 % CI 1.23, 1.61), and nicotine dependence (aPR = 1.46; 95 % CI 1.27, 1.69) compared to heterosexual males. Bisexual males had higher prevalence of nicotine dependence compared with heterosexual males

(aPR = 1.16; 95 % CI 1.02, 1.32). Both gay and bisexual males had lower prevalence of former smoking (aPR = 0.78; 95 % CI 0.69, 0.89 and aPR = 0.82; 95 % CI 0.73, 0.93, respectively; Fig. 2).

4. Discussion

Findings from the current study highlight that despite overall declines in cigarette smoking during 2015–2019, smoking disparities between LGB and heterosexual individuals are more pronounced for females compared with males, which is consistent with prior research (Li et al., 2021; Schuler and Collins, 2020; Fallin et al., 2015). Our findings also replicate prior research showing disproportionately high prevalence of current cigarette use among bisexual females (Li et al., 2021; Shokoochi et al., 2021). Importantly, the 36–44 % higher adjusted prevalence of current smoking among LGB individuals masked differences by sex, with prevalence among LGB females being 65 % higher than heterosexual females and 27 % higher among gay males compared with heterosexual males. Additionally, daily smoking was more prevalent among lesbian/gay and bisexual females compared with heterosexual females; for males, prevalence of daily smoking was higher among gay males, but not bisexual males, compared with heterosexual males. Further, the adjusted prevalence of nicotine dependence was higher for gay/lesbian and bisexual adults compared with heterosexual adults for both males and females.

Notably, we found that bisexual females reported the highest unadjusted prevalence of past-month cigarette smoking, daily cigarette smoking, and nicotine dependence, as well as the lowest unadjusted prevalence of former smoking, compared with all other groups; disparities between bisexual and heterosexual females remained for all of these tobacco-related outcomes after adjustment, though the confidence intervals for lesbian/gay and bisexual females overlap. With prior research showing that desire to quit and number of quit attempts do not differ between bisexual females and other groups (Fallin et al., 2015), our findings suggest that bisexual females may have more difficulty quitting and that population-level tobacco control efforts have not been as effective for bisexual females compared with other groups. These findings are confirmed by evaluations of two mass media campaigns. First, a published evaluation of the impact of the Centers for Disease Control's "Tips for Former Smokers" campaign supports that quitting intentions and behaviors were greater for heterosexual individuals compared with LGB individuals, though campaign effects were not examined by LGB subgroup (Wang et al., 2022). Second, while "This Free Life," the U.S. Food and Drug Administration's national, public education campaign for lesbian, gay, bisexual, and transgender (LGBT) adults, influenced numerous tobacco-related attitudes among LGBT young adults, the impact of the campaign on smoking behaviors among bisexual females in particular has not been examined, and the campaign messaging was not tailored to specific LGBT subgroups (Crankshaw et al., 2022; Guillery et al., 2021).

Our findings underscore the need for tobacco control interventions that are tailored toward bisexual females and address their unique experiences that may contribute to their smoking and quitting behaviors. Research informed by the Minority Stress Model (Meyer, 2003) suggests bisexual females may smoke to cope with stressors associated with identifying as bisexual, such as biphobia and monosexism (i.e., viewing only single-gender sexual orientations as legitimate) (Roberts et al., 2015). Bisexual females report particularly poor mental health outcomes (Ross et al., 2018) and lifetime victimization experiences (Hughes et al., 2010), suggesting that they experience unique vulnerabilities at the intersection of sex and sexual identity (Ross et al., 2018). Barriers to quitting that are unique to bisexual females (versus heterosexual females) include past-year substance use, internalizing problems, and externalizing problem severity and tobacco-related norms (Wheldon and Wiseman, 2021). Yet, a scoping review of smoking cessation interventions for LGBT populations published in 2023 reported that there were no interventions in the published literature that are tailored

Table 2

Former smoking prevalence, lifetime smoking prevalence, past-month cigarette smoking prevalence, past-month daily cigarette smoking prevalence, and nicotine dependence by sexual orientation. Data are combined from the 2015–2019 National Survey on Drug Use and Health, US adults ages 18 and older.

		% (95 % CI)				
		Former smoking	Lifetime smoking	Past-month cigarette smoking	Past-month daily cigarette smoking	Nicotine Dependence
Total	Heterosexual	49.3 (48.7, 49.9)	39.0 (38.6, 39.4)	17.9 (17.6, 18.2)	11.3 (11.0, 11.5)	9.2 (9.0, 9.4)
	Gay / Lesbian	38.2 (34.1, 42.5)	45.0 (42.5, 47.5)	25.2 (23.3, 27.1)	15.2 (13.9, 16.6)	12.6 (11.4, 14.0)
	Bisexual	27.1 (25.3, 28.9)	43.9 (42.3, 45.5)	29.3 (27.9, 30.7)	17.1 (16.2, 18.1)	14.3 (13.4, 15.3)
Female	Heterosexual	49.9 (49.0, 50.8)	33.7 (33.2, 34.2)	15.4 (15.1, 15.8)	10.3 (10.0, 10.6)	8.2 (7.9, 8.5)
	Gay / Lesbian	39.7 (34.6, 45.0)	48.1 (44.5, 51.7)	27.0 (24.4, 29.9)	16.2 (14.3, 18.4)	13.1 (11.3, 15.1)
	Bisexual	25.1 (23.0, 27.4)	44.9 (43.2, 46.7)	31.2 (29.6, 32.7)	18.7 (17.4, 20.0)	15.2 (14.1, 16.3)
Male	Heterosexual	48.8 (48.1, 49.6)	44.6 (44.0, 45.1)	20.6 (20.2, 21.0)	12.3 (12.0, 12.7)	10.3 (10.0, 10.5)
	Gay	36.9 (31.5, 42.7)	42.6 (39.5, 45.8)	23.7 (21.2, 26.4)	14.4 (12.4, 16.6)	12.3 (10.6, 14.3)
	Bisexual	32.4 (27.7, 37.4)	41.2 (37.4, 45.1)	24.7 (22.3, 27.2)	13.3 (11.7, 15.2)	12.1 (10.5, 14.0)

CI = confidence interval.

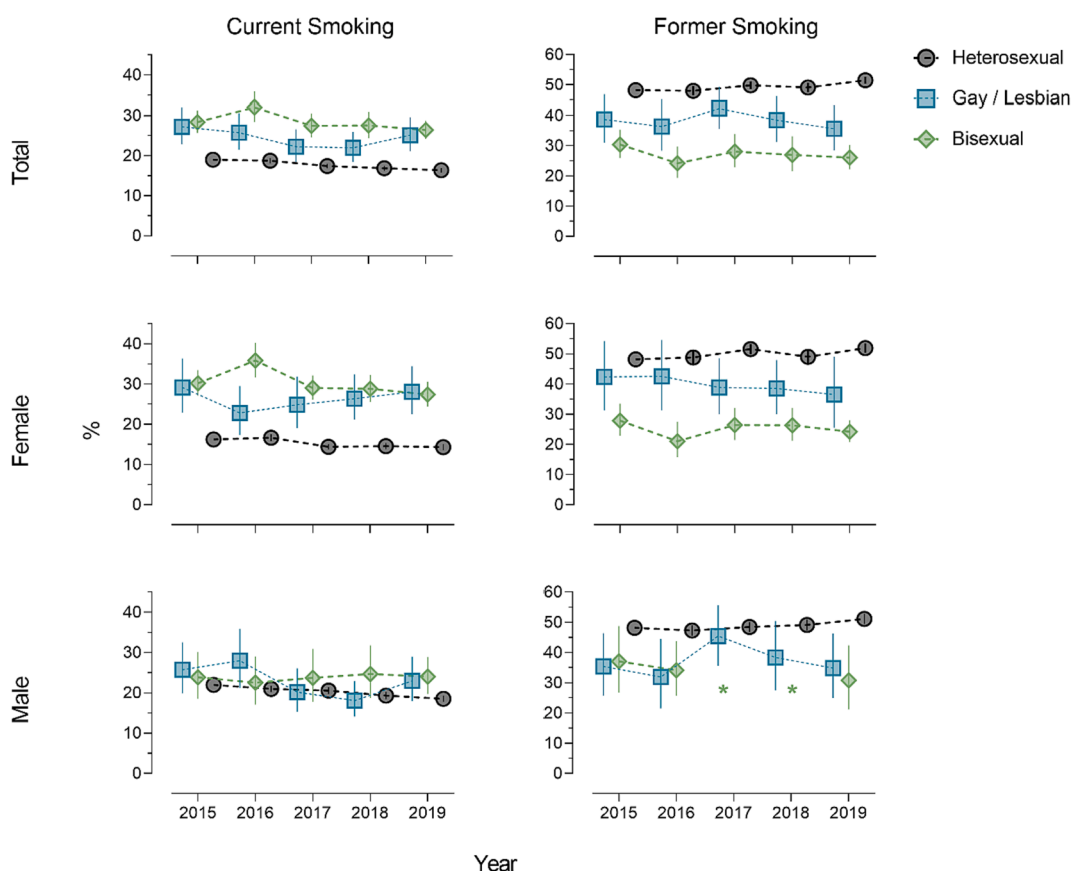


Fig. 1. Prevalence of adults indicating current and former cigarette smoking by sexual orientation by year. Data are from the 2015–2019 National Survey on Drug Use and Health, US adults ages 18 and older. *Note.* ^a Percentage of adults with 95% confidence intervals who reported current and former cigarette smoking each year. Along the y-axis is percentage of adults, beginning at 0% and ending at 40% for current and 60% for former. Along the x-axis is year. ^b Percentages are weighted ^c * Suppressed.

specifically to bisexual females (Riley et al., 2023).

This study has notable strengths, including using data from a large, nationally representative study and the examination of between- and within-group differences in cigarette smoking and cessation-related behaviors among LGB and heterosexual adults. However, while NSDUH is unique in that bisexual and lesbian/gay respondents can be examined separately in the public use file, other sexual identities (e.g., pansexual) are not measured. Further, former smoking is defined as not smoking in the past year, resulting in a lack of granularity in quitting behavior. Lastly, data are cross-sectional. Therefore, longitudinal

patterns of cigarette smoking and cessation-related behaviors were not examined.

5. Conclusions

Smoking disparities persist for LGB adults with notable within-group differences in a large, national sample. Stratifying analyses by sex revealed the highest prevalence of current and daily smoking and nicotine dependence, as well as lowest former smoking, in bisexual females. Findings highlight the need for research that examines the impact

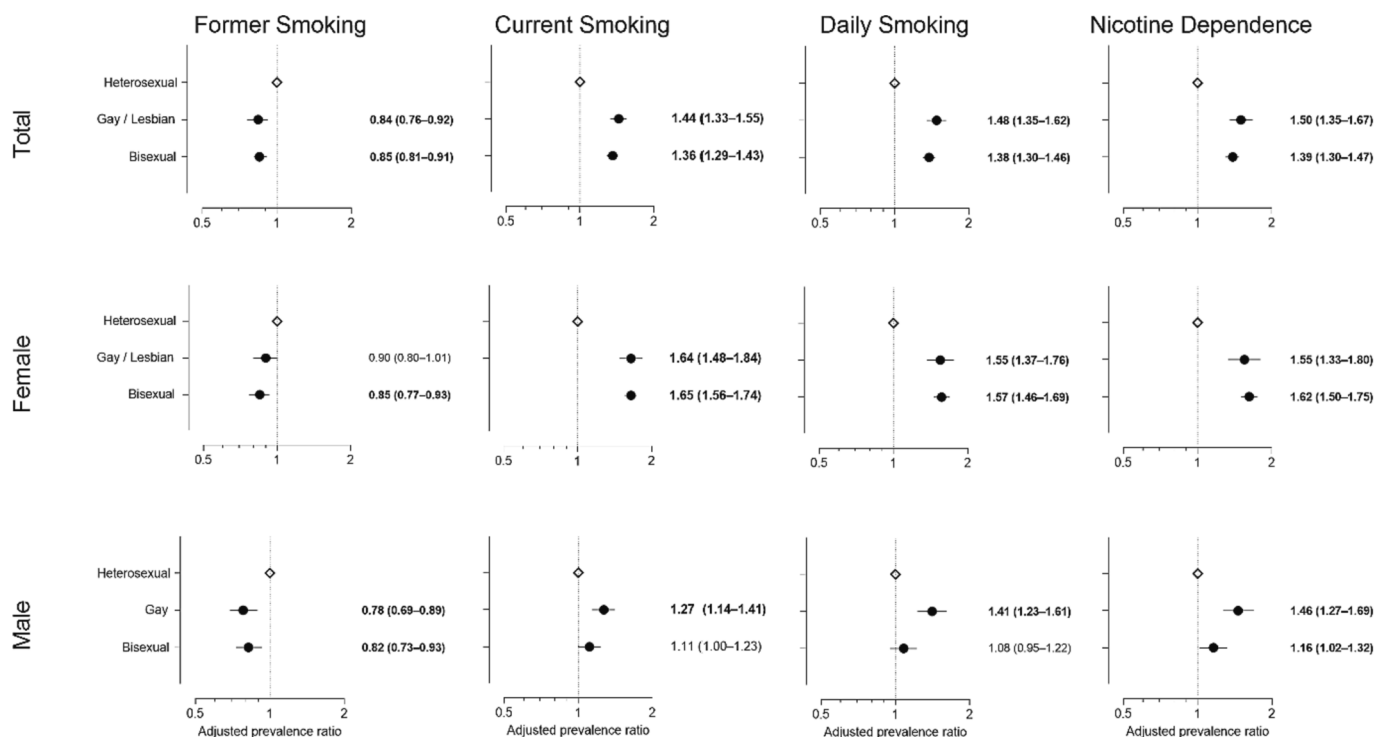


Fig. 2. Adjusted prevalence ratios of current, daily, and former smoking and nicotine dependence by sexual orientation. Data are combined from the 2015–2019 National Survey on Drug Use and Health, US adults ages 18 and older. *Note.* Prevalence ratio with 95 % confidence intervals controlling for age group, race/ethnicity, education, income, and year. Along the y-axis is sexual orientation by sex. The x-axis uses a log scale and represents the adjusted prevalence ratio. Estimates are weighted. Boldface indicates significance ($p < 0.05$) with people who identify as heterosexual serving as the reference group.

of population-level tobacco control interventions on different LGB subgroups, as well as research to inform tobacco control interventions tailored to the needs of bisexual females.

CRedit authorship contribution statement

Ollie Ganz: Writing – original draft, Writing – review & editing. **Jonathan A. Schulz:** Formal analysis, Writing – original draft, Writing – review & editing. **Sarah J. Ehlke:** Conceptualization, Writing – original draft, Writing – review & editing. **Jessica L. King Jensen:** Writing – original draft, Writing – review & editing. **Andrea C. Villanti:** Writing – original draft, 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.

Data availability

Data are public and cited in the paper

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