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Original Investigation

Nicotine and Tobacco Product Use and Dependence Symptoms Among US Adolescents and Adults: Differences by Age, Sex, and Sexual Identity

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Abstract

Introduction: Sexual minorities are at increased risk for tobacco use; however, there is heterogeneity in this risk by sociodemographic factors.

Aims and Methods: This study sought to understand if vulnerability to tobacco use among US sexual minorities varies by age group. For this study we used data from wave 4 of the Population Assessment of Tobacco and Health adolescent and adult surveys (n = 37 959), a nationally representative survey. We examined five nicotine/tobacco use outcomes by sex and sexual identity across four age groups. The five outcomes included past 30-day e-cigarette use, past 30-day cigarette use, past 30-day other tobacco use, the number of tobacco products used, and nicotine dependence symptoms.

Results: For males, sexual identity differences were greatest in middle adulthood, particularly for bisexual males; adjusted odds ratios and adjusted incident rate ratios ranged from 2.08 to 5.59 in middle adulthood compared to 0.83–1.62 in adolescence. For females, sexual identity differences were persistent from adolescence through middle adulthood. We found significant differences most consistently for nicotine dependence symptoms when comparing gay/lesbian and bisexual females across multiple age groups; adjusted incident rate ratios ranged from 1.90 in middle adulthood to 3.26 in adolescence.

Conclusions: Risk among sexual minorities varied considerably across age groups and by nicotine/tobacco product and severity of symptoms. Our findings underscore the importance of looking beyond single tobacco products when examining nicotine/tobacco differences related to sexual identity and in examining differences by age group. Our results demonstrating age-varying risk among sexual minorities have important implications for tobacco prevention and cessation efforts.

Implications: This study identifies important age variation in sexual minority differences in tobacco use, particularly among males. This study also shows that many sexual minorities not only have higher risk for tobacco and nicotine product use but also use significantly more tobacco products and have higher nicotine dependence symptom scores. These results have important implications for implementation of nicotine and tobacco prevention and cessation strategies for sexual minority adolescents and adults.

Introduction

US sexual minorities (individuals who have a sexual orientation different from heterosexual) are at increased risk for nicotine/tobacco use[1,2] and tobacco use disorders (TUDs)[3–6] in youth and adulthood. However, research suggests that there is heterogeneity in this risk by sociodemographic factors. For example, bisexual adults have high risk for nicotine/tobacco use and TUDs.[3,7] In addition, sexual minority females are consistently at increased risk for tobacco use, particularly bisexual females compared to heterosexual females.[4,8]

Some research has examined age differences in tobacco-related health outcomes and found that TUD is more prevalent among younger gay/lesbian women and gay men, whereas bisexual men and women had a high prevalence of TUD across young and middle adulthood.[6] Another study using national adult data found that sexual minority women had elevated risk for cigarette smoking across all adult age groups, but differences among men were limited to 35–49-year-olds.[9] However, studies to date do not examine the full age range from adolescence to middle adulthood and do not include a broad set of nicotine/tobacco use products and measures. Identifying the ages when differences are present is critical to designing effective intervention and treatment for sexual minorities. Additionally, the implications for tobacco-related health outcomes and how nicotine/tobacco use and nicotine dependence may influence health varies depending on what age differences are present.

Questions remain about the degree of risk for different tobacco products and if this vulnerability varies across the life course for sexual minority males and females. One national study from 2013 to 2014 examined sexual orientation differences across two age groups in adulthood but did not include adolescents nor examine the number of tobacco products used or nicotine dependence. This study found e-cigarette use was more prevalent among older gay men compared to older heterosexual men and more prevalent among younger and older sexual minority women compared to heterosexual women.[2] In addition, studies have found that sexual minorities are less likely to report cessation from tobacco products.[1] In cessation attempts, sexual minorities are more likely to use e-cigarettes as a cessation tool rather than FDA-approved cessation tools when attempting to quit,[10,11] suggesting prevalence of e-cigarette use may be higher among sexual minorities. Few studies measure or examine other tobacco products including little cigars/cigarillos, hookah, smokeless tobacco, or traditional cigars. Studies examining multiple tobacco products suggest that sexual identity differences do in fact vary by type of nicotine/tobacco product.[1,2] No studies have examined whether sexual minorities use more types of tobacco products compared to heterosexual individuals. However, studies of dual users (ie, users of both cigarettes and e-cigarettes) show an increased risk for dual use among sexual minorities.[12,13] This has important public health significance as use of more tobacco products is associated with greater risk for TUD[14,15] and negative health outcomes.[16]

This study used nationally representative data from 2016 to 2018 to examine age-related differences in multiple types of nicotine and tobacco products and nicotine dependence by sex and sexual identity across adolescence to middle adulthood. We use the term sexual identity to refer to how someone describes their own sexual orientation or attraction to another person and the behavior and/or social affiliation that may result from this attraction.[17] In doing so, we address three current gaps in the literature[1]: examination of sex, sexual identity, and age differences in a range of nicotine/tobacco use outcomes including the number of tobacco products and a nicotine dependence scale,[2] examination of differences across age groups spanning adolescence to middle adulthood, and[3] the examination of differences in a recent nationally representative sample. We hypothesize that sexual minorities, particularly bisexual women, will have higher risk for tobacco use outcomes compared to heterosexual individuals of the same sex. This increased risk will vary by age group.

Materials and Methods

Study Population

Data for this study came from wave 4 of the Population Assessment of Tobacco and Health (PATH) adolescent and adult surveys conducted in December 2016 through January 2018.[18,19] The PATH study is a nationally representative survey of adolescents (12–17 years) and adults (18 years and older) and used a four-state stratified address-based area probability sampling design. The retention rate was 79.5% for adolescents and 73.5% for adults. The analytic sample was limited to those who reported heterosexual, gay/lesbian, or bisexual sexual identity and were ages 14–60 (n = 37 959); n = 506 (1.3%) individuals were missing on variables of interest and were excluded from the analytic sample. Those ages 12–13 were not asked questions regarding sexual identity.

Measures

Sexual identity. Respondents were asked, "Do you think of yourself as[1]: Lesbian or gay,[2] straight,[3] bisexual,[4] something else,[5] don't know." Respondents selected one response option and those who responded "don't know" (0.4% of adults and 0.4% of adolescents), something else (2.3%), or did not respond (0.8% of adults and 0.3% of adolescents) were excluded from the analysis because of sample size. Previous research has suggested those who respond "something else" to have distinct risk for tobacco use.[3]

Sex. Respondents were asked, "What is your sex? [male, female]."

Past 30-day nicotine/tobacco use. Respondents reported whether or not they used nine different tobacco products in the past 30 days. From these questions, we created four different variables: *past 30-day e-cigarette use* (any use vs. none), *past 30-day cigarette use* (any use vs. none), and *past 30-day other tobacco use* (any use vs. none). Other tobacco use included cigars, cigarillos, smokeless tobacco, hookah, pipes, snus, or dissolvable tobacco use. Finally, we created a count variable of the *number of tobacco products* used in the past 30 days (0–9).

Nicotine dependence scale. We used items from the Brief Wisconsin Inventory of Smoking Dependence Motive (WISDM) scale that has seven primary subscales. The PATH study asks a subset of seven of the WISDM items in the adolescent and adult surveys to capture different domains of primary and secondary dependence motives[14,20–22] which have been used previously for adults and adolescents[14,15,23,24] to assess nicotine dependence. The seven subscales include automaticity, craving, loss of control, tolerance, negative reinforcement, cognitive enhancement, and affiliative attachment. See Strong et al.[14] for details on each item and the scale validity. Each of the seven items was asked on a five-point scale (0–4) and thus, the combined scale ranged from 0 to 28.

Other covariates. We stratified analyses by *sex* (male/female) and *age group* (12–18, 19–29, 30–44, and 45–60). In adjusted analyses, *race* (White, Black, Asian, and Multiracial/other), *ethnicity* (Hispanic vs. not), and *region* (Northeast, Midwest, South, and West) were also included as controls. In supplemental analyses,

we also include *past 30-day alcohol use* (any vs. none), *past 30-day marijuana use* (any vs. none), and *internalizing symptoms* (sum of four symptoms from the Global Appraisal of Individual Needs—Short Screener).[25,26]

Statistical Analysis

We examined the weighted prevalence of past 30-day e-cigarette use, cigarette use, and other tobacco use and calculated the mean number of nicotine/tobacco products and scores on the nicotine dependence scale by sexual orientation and sex across each of the four age groups. We then used multivariable logistic regression to examine associations of sexual identity with past 30-day e-cigarette use, cigarette use, and other tobacco use stratified by sex and age group while controlling for race, ethnicity, and region. Multivariable Poisson regression was used to examine associations of sexual identity with the number of nicotine/tobacco products used in the past 30 days and with the nicotine dependence scale stratified by sex and age group and controlling for race, ethnicity, and region. Mean number of nicotine/tobacco products and mean scores on the nicotine dependence scale were examined among the full study population and among individuals who reported past 30-day nicotine/tobacco use (n = 23 347). The main tables present results for regression analyses using heterosexual identity as the reference. Supplemental analyses were conducted using lesbian/gay identity as the reference in order to compare differences in risk between lesbian/gay identity and bisexual identity. In supplemental analyses, we also examined associations after controlling for past 30-day alcohol and marijuana use and internalizing symptoms to determine the extent to which other substance use and mental health may account for associations of sexual identity and tobacco use.

All estimates were weighted to represent the US adult population using the balanced repeated replication method[27] with Fay's adjustment at 0.3 to increase estimate stability,[28] as suggested by the PATH study.[26] The subpop option in Stata was used when conducting subgroup analyses in order to compute appropriate point and variance estimates.[29]

Results

Descriptives

The study population was 48% male, 74% White, 14% Black, 7% Asian, 6% Multiracial/Other, and 18% Hispanic. Almost one-third (31%) reported any past 30-day tobacco use, almost a quarter (23%) reported past 30-day cigarette use, 8% reported past 30-day e-cigarette use, and 12% reported other tobacco use in the past 30 days. Of those who used a nicotine/tobacco product in the past 30 days, individuals reported using between one and two nicotine/tobacco products (mean = 1.6) and had a mean score of 9 on the nicotine dependence scale (not included in Table 1).

Past 30-Day E-Cigarette Use, Cigarette Use, and Other Tobacco Use by Age, Sex, and Sexual Identity

Males. Table 2 presents unadjusted weighted prevalence estimates for past 30-day cigarette use, e-cigarette use, and other tobacco use by sex and sexual identity across the four age groups. Older bisexual males had substantially higher prevalence of e-cigarette use and cigarette use. For bisexual males ages 45–60, 15.4% reported past 30-day e-cigarette use compared to 3.8% of heterosexual males and 7.6% of gay males in this age group. For cigarette use, 47% of bisexual males ages 45–60 reported past 30-day use compared to 23% of heterosexual males and 25% of gay males in this age group. These differences were not as large in magnitude for younger age groups, nor were they as large for past 30-day use of other tobacco products.

Table 3 provides results examining associations of sexual identity with tobacco use by age group while adjusting for race, ethnicity, and region. Older bisexual males ages 45–60 had greater odds of past 30-day e-cigarette use (adjusted odds ratio [aOR] = 5.59, 95% confidence interval [CI] = 1.27% to 24.61%) and cigarette use (aOR = 2.84, 95% CI = 1.02% to 7.88%) compared to heterosexual men of the same age group. For other tobacco use, gay males ages 19–29 (aOR = 0.39, 95% CI = 0.26% to 0.59%) and ages 45–60 (aOR = 0.18, 95% CI = 0.07% to 0.46%) were significantly less likely to report use compared to heterosexual males.

Females. Bisexual and gay/lesbian females had higher prevalence of past 30-day e-cigarette use, cigarette use, and other tobacco use for all ages (Table 2). For example, past 30-day e-cigarette use was reported by 21% of bisexual females and 18% of gay/lesbian females ages 19–29 compared to 8% of heterosexual females. The magnitude of differences was somewhat larger in young adulthood compared to adolescence or middle adulthood. After adjusting for race, ethnicity, and region, bisexual and gay/lesbian females across most age groups had significantly greater odds of past 30-day e-cigarette use and other tobacco use (Table 3). Differences in past 30-day cigarette use were concentrated in younger ages with no significant differences for gay/lesbian females ages 30–44 or 45–60 and no significant differences for bisexual females 45–60 compared to heterosexual females in the same age group.

Number of Nicotine/Tobacco Products and Nicotine Dependence by Age, Sex, and Sexual Identity

Males. Table 2 provides estimated mean number of tobacco products used in the past 30 days and the mean score on the nicotine dependence scale by sex and sexual identity across four age groups. Additionally, Figure 1 depicts the number of tobacco products used for each sex, sexual identity, and age group and Figure 2 depicts the nicotine dependence scores for each sex, sexual identity, and age group. Among males, sexual identity differences appeared largest for bisexual males in the 45–60 age group. Bisexual males reported an average of 1.27 nicotine/tobacco products, gay males averaged 0.36 products, and heterosexual males averaged 0.48 products. Similarly, bisexual males scored 7.42 on average on the nicotine dependence scale while gay and heterosexual men were more similar with scores of 3.89 and 3.48, respectively.

In adjusted analyses, we found significant differences by sexual identity subgroup with bisexual males ages 45–60 using significantly more tobacco products (adjusted incident rate ratio [aIRR] = 2.86, 95% CI = 1.09% to 7.52%) and having a significantly higher score on the nicotine dependence scale (aIRR = 2.08, 95% CI = 1.22% to 3.57%). Additionally, gay males ages 19–29 used significantly fewer tobacco products in the past 30 days compared to heterosexual males (aOR = 0.73, 95% CI = 0.58% to 0.93%).

Females. Bisexual females reported a mean of 1.5–1.8 nicotine/tobacco products used in the past 30 days compared to gay/lesbian females who reported a mean of 0.3–1.0 products across age groups and heterosexual females who reported a mean of 0.2–0.4 products across age groups. Similarly, nicotine dependence scores were higher for bisexual and gay/lesbian females compared to heterosexual females across all ages, with the largest differences in young adulthood.

Table 1. Weighted Descriptives of Adolescent and Adult Respondents (14 Years and Older) in the Population Assessment of Tobacco and Health W4 (2016–2018; *n* = 37 959)

	Wave 4, 2016–2018			
Variables	Overall, *n* = 37 959 %/M (SE)	Heterosexual, *n* = 34 883 %/M (SE)	Gay/lesbian, *n* = 863 %/M (SE)	Bisexual, *n* = 2213 %/M (SE)
Age (in years)				
14–18	10.5	10.1	10.6	21.0
19–29	24.5	23.6	33.2	41.3
30–44	30.6	30.9	26.0	24.4
45–60	34.5	35.4	30.1	13.3
Sex				
Male	49.6	50.4	54.7	25.5
Female	50.4	49.6	45.3	74.5
Race				
White	73.7	73.8	72.4	73.5
Black	13.9	13.8	16.4	13.4
Asian	6.7	6.8	4.5	4.0
Multiracial/other	5.7	5.6	6.7	9.1
Hispanic	17.8	17.8	22.9	15.0
Region				
Northeast	17.7	17.5	20.8	19.1
Midwest	20.9	21.0	14.7	21.7
South	37.4	37.4	39.9	37.3
West	24.0	24.0	24.6	21.9
Any past 30-day nicotine/tobacco use	30.6	29.9	39.0	44.8
Past 30-day cigarette use	23.1	22.4	31.7	35.4
Past 30-day e-cigarette use	7.7	7.2	11.6	17.1
Past 30-day other tobacco use[a]	12.2	12.0	12.7	17.5
Past 30 day number of nicotine/tobacco products (range 0–9)	0.49 (0.01)	0.48 (0.01)	0.63 (0.04)	0.83 (0.05)
Nicotine dependence scale (range 0–28)	2.81 (0.04)	2.72 (0.04)	4.03 (0.34)	4.45 (0.25)

Some row percentages do not add up to 100% because of rounding.

[a]Other tobacco use includes cigars, cigarillos, smokeless, hookah, pipes, snus, and dissolvable tobacco.

Table 2. Nicotine/Tobacco Use and Dependence by Age, Sex, and Sexual Identity Among W4 Population Assessment of Tobacco and Health Respondents (2016–2018; $n = 37\,959$)

	Males			Females		
	Heterosexual	Gay	Bisexual	Heterosexual	Gay/Lesbian	Bisexual
Age group	%/mean (95% CI)	%/mean (95% CI)	%/mean (95% CI)	%/mean (95% CI)	%/mean (95% CI)	%/mean (95% CI)
Past 30-day e-cigarette use						
14–18	9.4 (8.5, 10.3)	5.5 (0.3, 10.7)	12.1 (7.4, 16.7)	7.2 (6.4, 8.1)	6.7 (2.4, 11.0)	12.9 (10.0, 15.8)
19–29	15.7 (14.5, 16.9)	12.9 (8.5, 17.4)	21.7 (14.1, 29.4)	7.9 (7.2, 8.7)	17.6 (11.5, 23.7)	20.9 (16.5, 25.3)
30–44	8.8 (7.8, 9.8)	7.5 (1.9, 13.0)	13.2 (3.6, 22.8)	5.0 (4.3, 5.7)	16.4 (5.3, 27.5)	19.0 (13.2, 24.8)
45–60	3.8 (3.2, 4.4)	7.6 (1.9, 13.3)	15.4 (0.1, 32.3)	4.0 (3.5, 4.6)	12.7 (5.7, 19.6)	5.4 (0.7, 10.2)
Past 30-day cigarette use						
14–18	7.2 (6.4, 8.0)	10.1 (2.9, 17.4)	12.1 (7.7, 16.5)	5.0 (4.2, 5.7)	11.9 (5.4, 18.3)	12.9 (10.4, 15.4)
19–29	31.4 (29.7, 33.2)	32.9 (25.6, 40.2)	32.1 (23.6, 40.7)	19.6 (18.5, 20.7)	40.8 (33.0, 48.6)	44.9 (39.6, 50.3)
30–44	29.1 (27.3, 30.8)	39.5 (22.7, 56.5)	41.2 (22.9, 59.6)	21.7 (20.2, 23.3)	36.2 (19.3, 53.2)	42.6 (33.8, 51.4)
45–60	23.4 (21.9, 24.9)	24.6 (12.9, 36.2)	47.0 (25.7, 68.3)	20.9 (19.4, 22.4)	33.6 (19.7, 47.4)	32.7 (21.0, 44.4)
Past 30-day other tobacco use[a]						
14–18	8.8 (8.0, 9.7)	15.1 (6.2, 24.0)	7.5 (3.1, 11.8)	3.2 (2.7, 3.8)	10.2 (3.8, 16.6)	9.9 (7.1, 12.6)
19–29	25.9 (24.5, 27,4)	12.8 (8.0, 17.7)	26.4 (18.2, 34.6)	11.9 (10.8, 13.1)	27.8 (21.3, 34.3)	23.4 (20.1, 26.7)
30–44	18.9 (17.4, 20.4)	11.3 (3.5, 19.1)	17.0 (6.5, 27.5)	5.0 (4.3, 5.8)	14.5 (6.2, 22.8)	14.6 (9.2, 20.0)
45–60	14.7 (13.0, 16.4)	2.8 (0.2, 5.4)	17.8 (1.0, 34.6)	3.2 (2.6, 3.8)	10.0 (2.7, 17.2)	11.0 (2.3, 19.7)
Number of nicotine /tobacco products						
14–18	0.32 (0.29, 0.34)	0.44 (0.16, 0.71)	0.34 (0.22, 0.45)	0.17 (0.15, 0.19)	0.30 (0.15, 0.45)	0.39 (0.32, 0.47)
19–29	0.90 (0.85, 0.94)	0.67 (0.52, 0.82)	1.01 (0.72, 1.30)	0.44 (0.41, 0.47)	1.03 (0.85, 1.22)	1.02 (0.91, 1.12)
30–44	0.67 (0.63, 0.71)	0.65 (0.37, 0.93)	0.76 (0.49, 1.04)	0.34 (0.32, 0.36)	0.73 (0.40, 1.06)	0.91 (0.68, 1.14)
45–60	0.48 (0.45, 0.52)	0.36 (0.19, 0.52)	1.27 (0.16, 2.39)	0.29 (0.27, 0.32)	0.61 (0.35, 0.87)	0.54 (0.29, 0.79)
Nicotine dependence scale (0–28)						
14–18	0.75 (0.65, 0.85)	2.23 (0.66, 3.81)	1.33 (0.82, 1.85)	0.42 (0.35, 0.48)	0.87 (0.29, 1.45)	1.41 (1.07, 1.74)
19–29	3.18 (2.99, 3.37)	3.89 (2.60, 5.19)	3.80 (2.62, 4.98)	1.87 (1.74, 2.00)	4.38 (3.24, 5.52)	5.00 (4.26, 5.74)
30–44	3.67 (3.44, 3.90)	4.60 (2.49, 6.72)	4.02 (1.55, 6.48)	2.50 (2.31, 2.68)	4.26 (1.96, 6.56)	5.76 (4.47, 7.05)
45–60	3.48 (3.24, 3.72)	3.89 (2.02, 5.76)	7.42 (3.87, 10.97)	2.78 (2.55, 3.00)	5.35 (3.08, 7.61)	5.95 (3.68, 8.23)

[a]Other tobacco use includes cigars, cigarillos, smokeless, hookah, pipes, snus, and dissolvable tobacco.

Table 3. Adjusted Associations of Sexual Orientation With Nicotine/Tobacco Use and Dependence by Age and Sex, Population Assessment of Tobacco and Health Wave 4 Study (*n* = 37 959)

	Males				Females			
	14–18 *n* = 5628	19–29 *n* = 5963	30–44 *n* = 3234	45–60 *n* = 3012	14–18 *n* = 5165	19–29 *n* = 6171	30–44 *n* = 3471	45–60 *n* = 3219
Predictor	aOR/aIRR	aOR/aIRR	aOR/aIRR	aOR/aIRR	aOR/aIRR	aOR/aIRR	aOR/aIRR	aOR/aIRR
Past 30-day e-cigarette use								
Gay/lesbian	0.52 (0.17, 1.57)	0.73 (0.45, 1.18)	0.94 (0.41, 2.19)	2.24 (0.95, 5.29)	0.98 (0.44, 2.19)	**2.21 (1.40, 3.50)****	**3.64 (1.50, 8.79)****	**3.10 (1.49, 6.44)****
Bisexual	1.22 (0.79, 1.90)	1.56 (1.00, 2.44)	1.67 (0.65, 4.29)	**5.59 (1.27, 24.61)***	**1.94 (1.47, 2.57)*****	**2.96 (2.21, 3.97)*****	**3.94 (2.54, 6.11)*****	1.22 (0.48, 3.06)
Past 30-day cigarette use								
Gay/lesbian	1.34 (0.53, 3.39)	1.07 (0.75, 1.51)	1.97 (0.87, 4.26)	1.22 (0.65, 2.25)	**2.48 (1.19, 5.19)***	**2.81 (1.98, 4.00)*****	2.04 (0.96, 4.30)	1.69 (0.89, 3.22)
Bisexual	**1.76 (1.11, 2.78)***	1.07 (0.72, 1.59)	1.26 (0.55, 2.91)	**2.84 (1.02, 7.88)***	**2.82 (2.17, 3.66)*****	**3.09 (2.45, 3.91)*****	**2.40 (1.65, 3.48)*****	1.63 (0.99, 2.68)
Past 30-day other tobacco use								
Gay/lesbian	1.69 (0.78, 3.63)	**0.39 (0.26, 0.59)*****	0.48 (0.21, 1.10)	**0.18 (0.07, 0.46)****	**3.19 (1.42, 7.14)****	**2.27 (1.53, 3.35)*****	**2.99 (1.49, 6.01)****	**3.23 (1.30, 8.00)***
Bisexual	0.83 (0.41, 1.66)	1.08 (0.72, 1.63)	0.86 (0.40, 1.86)	1.52 (0.42, 5.53)	**3.01 (2.14, 4.40)*****	**2.29 (1.83, 2.86)*****	**3.15 (1.90, 5.21)*****	**3.62 (1.46, 9.00)****
Number of nicotine/tobacco products (0–9)								
Gay/lesbian	1.23 (0.59, 2.54)	**0.73 (0.58, 0.93)***	1.03 (0.68, 1.55)	0.84 (0.54, 1.30)	**1.78 (1.01, 3.15)***	**2.05 (1.69, 2.49)*****	**2.04 (1.32, 3.16)****	**1.88 (1.22, 2.90)****
Bisexual	1.02 (0.70, 1.49)	1.17 (0.89, 1.54)	1.04 (0.70, 1.54)	**2.86 (1.09, 7.52)***	**2.30 (1.87, 2.83)*****	**2.21 (1.95, 2.51)*****	**2.44 (1.88, 3.17)*****	**1.67 (1.14, 2.46)****
Nicotine dependence scale (0–28)								
Gay/lesbian	**2.75 (1.20, 6.29)***	1.22 (0.87, 1.71)	1.46 (0.95, 2.25)	1.25 (0.79, 1.98)	2.06 (0.97, 4.34)	**2.48 (1.87, 3.30)*****	**1.77 (1.08, 2.91)***	**1.81 (1.16, 2.82)***
Bisexual	**1.62 (1.03, 2.54)***	1.19 (0.89, 1.60)	1.02 (0.52, 2.03)	**2.08 (1.22, 3.57)****	**3.26 (2.54, 4.18)*****	**2.38 (2.02, 2.81)*****	**2.03 (1.59, 2.58)*****	**1.90 (1.33, 2.72)*****

Reference is heterosexual of same age and same sex. Models control for race, ethnicity, and census region. Sexual identity × Age category interactions were significant for both sexes across all outcomes. Dichotomous outcomes of past 30-day e-cigarette use, past 30-day cigarette use, and past 30-day other tobacco use were modeled with logistic regression and number of tobacco use products and nicotine dependence scale was modeled using Poisson regression $^{*}p < .05$, $^{**}p < .01$, and $^{***}p < 0.001$. aIRR = adjusted incident rate ratio, aOR = adjusted odds ratio.

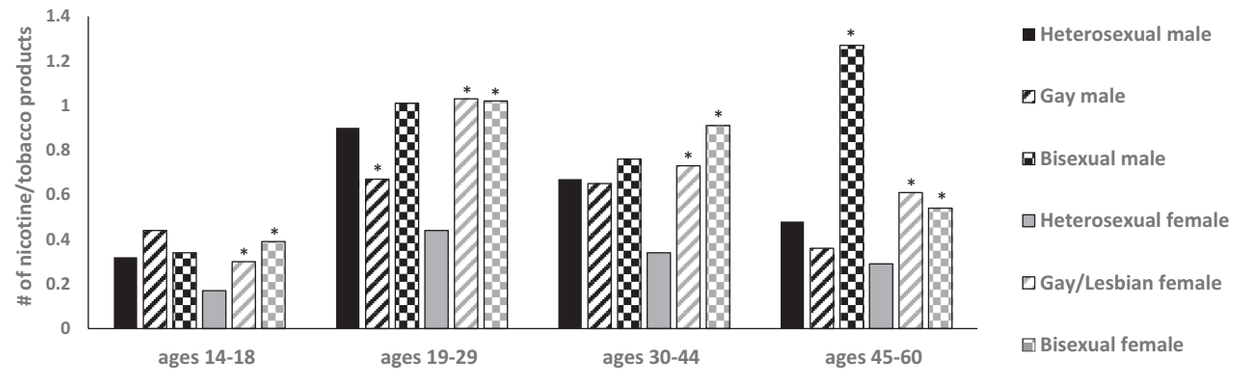

Figure 1. Number of nicotine/tobacco products by sex and sexual identity across four age groups (n = 37 959). *Significantly different from heterosexual of the same sex and age group at $p < .05$ after controlling for race, ethnicity, and region.

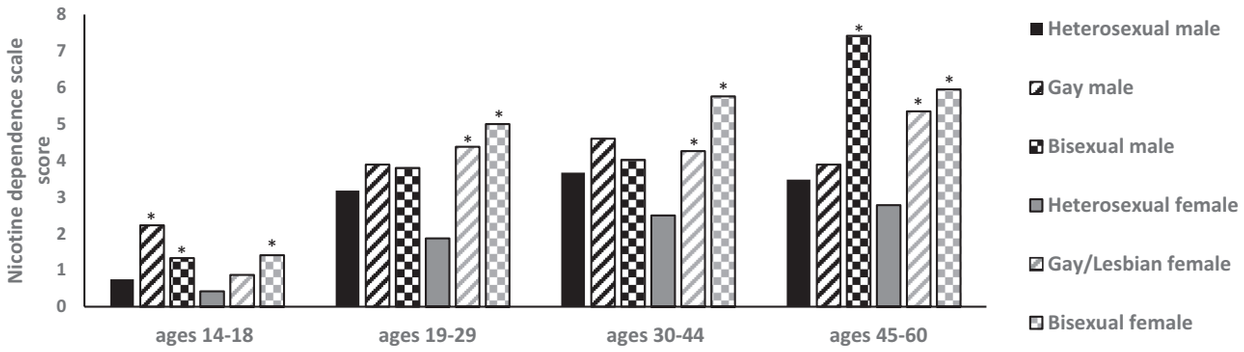

Figure 2. Nicotine dependence scale by sex and sexual identity across four age groups (n = 37 959). *Significantly different from heterosexual of the same sex and age group at $p < .05$ after controlling for race, ethnicity, and region.

In adjusted analyses, we found these differences to be significant with gay/lesbian and bisexual females' reported use of significantly more nicotine/tobacco products in the past 30 days compared to heterosexual females across all four age groups (aIRR ranged from 1.67 to 2.44). Bisexual females had significantly higher nicotine dependence scores compared to heterosexual females across all four age groups. Gay/lesbian females had significantly higher nicotine dependence scores compared to heterosexual females among ages 19–29, 30–44, and 45–60.

In Supplementary Table A, we examined the number of nicotine/tobacco products used in the past 30 days by sex and sexual identity across the four age groups among those who reported nicotine/tobacco use. For males who used nicotine/tobacco, gay males ages 45–60 used significantly fewer nicotine/tobacco products and bisexual males ages 45–60 were not significantly different from heterosexual males of the same age group in the number of nicotine/tobacco products used. However, gay males and bisexual males ages 45–60 had significantly higher nicotine dependence scores compared to heterosexual males ages 45–60. Gay males ages 14–18 and 19–29 had significantly higher nicotine dependence scores compared to heterosexual males in the same age group. For females who used nicotine/tobacco, bisexual females ages 19–29 and 30–44 used significantly more nicotine/tobacco products than heterosexual females in the same age group. Gay/lesbian and bisexual females ages 19–29 who used nicotine/tobacco also had a higher nicotine dependence scale score compared to heterosexual females.

In Supplementary Table B, we conducted the same regressions as presented in Table 3 that examine associations of sexual identity with tobacco use outcomes by sex and age group but switched the reference group to gay/lesbian to compare gay/lesbian and bisexual subgroups. Bisexual males ages 45–60 had significantly greater odds of past 30-day other tobacco use (aOR = 7.69, 95% CI = 2.20% to 26.94%), used significantly more nicotine/tobacco products (aIRR = 3.39, 95% CI = 1.29% to 8.96%), and had a higher nicotine dependence score (aIRR = 3.26, 95% CI = 2.54% to 4.18%) compared to gay males in the same age group. Bisexual females across all four age groups had a higher nicotine dependence score compared to gay/lesbian females in the same age group (aIRR range from 1.90 to 3.26).

In Supplementary Table C, we conducted the same regression models in Table 3 but added the internalizing symptoms, alcohol use, and marijuana use as additional controls to examine if results changed. The addition of these controls attenuated results and in some cases resulted in associations becoming nonsignificant. In particular, bisexual males and females ages 45–60 were no longer significantly different from heterosexual individuals of the same sex and age group for three of the tobacco outcomes. We discuss the implications for these findings in the discussion. Additionally, gay men ages 30–44 compared to heterosexual men ages 30–44 moved to significantly less likely to use other tobacco with the inclusion of these additional covariates (aOR = 0.38, 95% CI = 0.17% to 0.85%).

Discussion

This study examined sexual identity differences in a number of tobacco and nicotine-related outcomes across multiple age groups from adolescence to middle adulthood. In particular, we found that sexual minorities are not only at greater risk for cigarette use,

e-cigarette use, and in some cases, other tobacco products, but many sexual minority subgroups also used a greater number of tobacco products and had higher nicotine dependence symptoms scores. For males, this increased risk was mostly limited to middle adulthood, while for females, sexual identity differences were persistent from adolescence through middle adulthood.

The high risk for sexual minority women is largely consistent with previous literature that has found tobacco use risk to be particularly high for sexual minority women.[3,4,30,31] Still, the substantially elevated risk for sexual minority women across every nicotine/tobacco use outcome and every age group from adolescence through middle adulthood is striking. Previous research has pointed to increased stressors experienced by sexual minorities, some of which are particularly prevalent among sexual minority women, as important contributors to elevated risk among this subgroup.[4,32,33] In addition, intersectionality theory suggests that the social location of sexual minority women—reflecting multiple, historically marginalized identities—may play an important role in understanding this risk.[34] Social inequalities resulting from sexism and heterosexism may contribute to these greater differences among women.[35] Sexual minority women have higher prevalence of stressors in childhood and adulthood and higher prevalence of mental health disorders,[4,36] and higher mental health comorbidities[4] which may contribute to a higher risk for tobacco use and greater nicotine dependence. In fact, our supplemental analyses suggest that mental health and other comorbidities may be important contributing factors for bisexual women in midadulthood as tobacco differences for bisexual compared to heterosexual women were attenuated when accounting for mental health and other substance use. Interventions to reduce these stressors early in the life course, as well as nicotine/tobacco cessation interventions that are tailored to sexual minority women and the stressors that they experience, are critical to reducing tobacco-related disparities among bisexual women. In addition, structural interventions that reduce discrimination and marginalization of minority populations are also a necessary component to reducing tobacco-related disparities.

In supplemental analyses, we found minimal evidence of increased risk for any of the tobacco/nicotine outcomes among bisexual women compared to gay/lesbian women with the exception of nicotine dependence scores. Bisexual women had significantly higher nicotine dependence symptom scores across all age groups compared to gay/lesbian women. There is some evidence of earlier age of tobacco use initiation among bisexual individuals[37] which may contribute to more severe nicotine dependence. Bisexual individuals may experience "biphopia"[38] and stigmatizing views of bisexuality by both heterosexual and gay/lesbian individuals,[39] in part, related to a dominant binary view of sexual orientation. Relatedly, bisexual individuals report lower levels of social connectedness.[40] These factors may contribute to a higher risk for tobacco use for bisexual individuals. In fact, our supplemental analyses showed that, particularly for bisexual individuals in midadulthood, accounting for mental health (along with other substance use), resulted in nonsignificant findings for bisexual compared to heterosexual individuals in many of the outcomes we examined. However, for some outcomes and for other age groups, bisexual individuals remained at higher risk. Still, this suggests mental health and couse of other substances may play a role in elevated risk for tobacco use. Given the increased health risks associated with greater nicotine/tobacco use, these findings stress the importance of intervention in this population and highlight the heterogeneity of risk among sexual minority women and bisexual women in particular.

The finding that tobacco use and nicotine dependence symptoms differences are greatest for bisexual men in older ages has important implications for health. Lung cancer risk and other serious health consequences from tobacco use increase in middle and older adulthood. Thus, sexual minority men in this age range are an important target for lung cancer screening, particularly given their current low rates of lung cancer screening.[41] In addition, treatment seeking is particularly low among bisexual men with one study finding only 11% of bisexual men with history of a TUD ever seeking treatment.[11] Efforts to provide evidence-based tobacco cessation services in settings serving sexual minority communities are critical to reducing nicotine/tobacco use among sexual minorities.[42] In addition, we found that adjusting for mental health and other substance use attenuated these differences. While this does not discount the substantially higher tobacco-related health risks midadult bisexual men may experience, it does point to potential drivers of these differences and suggest that mental health treatment as well could be instrumental in alleviating tobacco-related health risks for this subgroup.

Adults ages 45–60 who currently use tobacco scored higher on the nicotine dependence symptoms scale, potentially increasing difficulty in successful tobacco cessation. This may be related to the high use of e-cigarettes among sexual minority males and females in this age group. Previous research has suggested that sexual minorities are more likely to report using e-cigarettes as a cessation method rather than FDA-approved cessation tools such as nicotine replacement therapy or counseling.[10,11] Thus, higher prevalence of e-cigarette use among older sexual minorities may be related to cessation motives. Future research should explore how motivations vary by sex, sexual identity, and age.

Among adolescents, we found few differences between sexual minority and heterosexual males in nicotine/tobacco use. However, both bisexual and gay males had significantly higher scores on the nicotine dependence scale. We also found young adult and older adult gay males were less likely than heterosexual males to use other tobacco products and use fewer tobacco products. We did not see a lower risk for gay males in e-cigarette or cigarette use. This may suggest that gay males' tobacco use risk is more specialized in specific tobacco products. Previous research has found sexual minority men are less likely to use pipes and smokeless tobacco.[2,43] More research is needed to better understand differences for other tobacco products. This underscores the importance of looking beyond use of single tobacco products when examining these disparities. This also complements other studies that have found lower prevalence of tobacco/nicotine cessation[44] and higher prevalence of reuptake of tobacco/nicotine products among sexual minorities.[45] Thus, secondary prevention efforts for sexual minority males are warranted as greater dependence severity is associated with greater difficulty quitting and greater risk for persistent tobacco use across the life course.[46]

Limitations

This study was cross-sectional and thus was not able to disentangle age and cohort effects. The use of cross-sectional data also limited our ability to take into account potential changes in sexual identity over time. There is considerable data to support the fact that sexual identity develops and may change over the life course.[47–49] Additionally, there is evidence that younger respondents are more likely to disclose sexual identity than older respondents, potentially because of historical differences in stigma.[50] Future research is needed that examines changes in sexual identity over the life course and how it is associated with changes in risk for tobacco use as well as how disclosure of sexual identity may

differ across age and cohort. This study was also based on self-report survey data and thus has all the limitations of any survey study regarding recall bias and social desirability bias. In addition, we were not able to include individuals who responded with "something else" regarding their sexual identity because of low sample size. Previous research has found that this group to have a distinct tobacco use risk[3] and that additional options for sexual minorities may impact their response.[51] We were also not able to examine transgender individuals because of sample size limitations. Finally, some confidence intervals were large, particularly for some sexual minority men. However, findings from other national studies fit a similar pattern, providing additional assurance that our conclusions are valid.[6,9]

Conclusions

Sexual minorities are at risk for nicotine/tobacco use, using more tobacco products than heterosexuals, and greater nicotine dependence symptoms relative to heterosexuals. Among sexual minority men, these differences were largest during middle adulthood, highlighting the need for secondary and tertiary prevention in this age group. Prevention and cessation efforts should be tailored to the needs of sexual minorities and consider their age-varying differences in nicotine/tobacco use.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

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Declaration of Interests

The authors have no conflicts of interest to declare. The authors have had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. The manuscript is not under review—and will not be under review—by another publication while it is being considered by *Nicotine & Tobacco Research*.

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