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Original Investigation

Vaping Disparities at the Intersection of Gender Identity and Race/Ethnicity in a Population-Based Sample of Adolescents

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Abstract

Background: Transgender adolescents use vape products (eg, e-cigarettes) at higher rates than cisgender adolescents. Little is known about how these disparities differ from the intersectional perspective of both gender identity and race/ethnicity.

Methods: We examined disparities in past 30-day vaping frequency at the intersection of gender identity and race/ethnicity among adolescents participating in two pooled waves of the population-based California Healthy Kids Survey (N = 953 445; 2017–2019). Generalized linear mixed models included gender identity-by-race/ethnicity interactions and adjusted for potential confounders. Stratified models quantified relationships between gender identity and vaping within race/ethnicity strata and between race/ethnicity and vaping within gender identity strata.

Results: Transgender adolescents of color were more likely to report a higher frequency of vaping than cisgender white adolescents. In models stratified by race/ethnicity, transgender adolescents evidenced greater odds of more frequent vaping than cisgender adolescents of the same race/ethnicity; disparities were greatest between transgender and cisgender Black adolescents (adjusted odds ratio [AOR]: 6.05, 95% CI: 4.76–7.68) and smallest between transgender and cisgender white adolescents (AOR: 1.20, 95% CI: 1.06–1.35). In models stratified by gender identity, disparities were greatest between transgender Black and transgender white adolescents (AOR: 2.85, 95% CI: 2.20–3.70) and smallest between transgender multiracial and transgender white adolescents (AOR: 1.28, 95% CI: 1.05–1.58). Similar, though less consistent, patterns emerged for adolescents of color unsure of their gender identity relative to cisgender white adolescents.

Conclusion: Transgender adolescents of color may be especially vulnerable to vaping disparities. Future research should identify and intervene on causal mechanisms undergirding disparities.

Implications: Research finds that transgender adolescents use vape products at higher rates than their cisgender peers, however, little is known about how patterns of adolescent vaping may differ by both gender identity and race/ethnicity, information needed to inform culturally tailored prevention and control initiatives to decrease adolescent vaping disparities. Our analysis of data from a population-based adolescent health survey finds evidence of magnified disparities in vaping frequency among transgender adolescents of color.

Introduction

Adolescent use of electronic vapor products ("vaping"), including electronic cigarettes, vaporizers, and vape pens—with and without nicotine—is an emergent public health epidemic in the United States.[1,2] Vaping nicotine during adolescence is associated with increased risk for cigarette smoking initiation and co-use of alcohol, cannabis, and other substances.[1,3,4] Vape products not containing nicotine may also have negative health effects, although these effects are not well understood.[1,5] For example, evidence suggests that vape cartridges with THC (the primary psychoactive substance of cannabis) may be related to recent outbreaks of severe lung injury in the United States[5] and flavored e-liquid found in vape products with and without THC contain health-harming toxins.[1,6]

Since 2011, the past 30-day prevalence of adolescent vaping has increased steadily, peaking in 2019 at approximately 30%.[7,8] Although adolescent vaping prevalence dropped to approximately 20% in 2020, it remains high.[7] Given the potential negative health consequences associated with vaping, adolescent vaping prevention must be a public health priority. Ideally, prevention efforts will target the most vulnerable, however, there is a limited evidence base regarding differences in vulnerability across adolescent groups.

One group that may be at high risk for vaping is transgender adolescents. By transgender, we mean adolescents whose gender identity is not aligned with their sex assigned at birth, and by cisgender, we mean adolescents whose gender identity aligns with their sex assigned a birth. Although limited, research with nationally representative and population-based surveys finds transgender adolescents are more likely to smoke combustible cigarettes[9–11] and vape[12,13] than their cisgender peers. Vaping[14] and smoking[15] disparities among transgender people have been explained by the gender minority stress model. The model posits that chronic exposure to multilevel gender minority-related prejudice and discrimination (eg, self-monitoring, family or peer rejection, and discrimination in access to resources and opportunities) predisposes transgender and other gender minority people to excess stress and, in turn, negative health outcomes and health disparities.[16] Indeed, past research has found that tobacco-and substance use-related disparities among transgender adolescents may be related to violence and victimization, community norms favoring substance use, and targeting of LGBTQ (lesbian, gay, bisexual, transgender, queer or questioning) people by tobacco and alcohol companies.[17–19]

While examinations of gender identity disparities in adolescent tobacco use—vaping in particular—are uncommon,[20] even less is known about how these disparities vary by race/ethnicity, ie, disparities at the intersection of gender identity and race/ethnicity. Indeed, vaping among transgender adolescents of color may differ significantly from their non-Latinx white peers given exposure to multiple and intersecting individual, interpersonal, and structural-level forms of racism and cisgenderism (ie, "cultural and systemic ideology that denies, denigrates, or pathologizes self-identified gender identities that do not align with assigned gender at birth as well as resulting behavior, expression, and community" (p. 63)[21]). These intersecting, multiplicative experiences of racism and cisgenderism, and resultant stress and coping can be understood through the lens of intersectionality. A theoretical framework rooted in Black feminist thought, intersectionality examines relationships between macro-level interlocking systems of power and individual-level experiences and behaviors across multiple social positions (eg, by race, socioeconomic position, gender).[22,23] As a tool, intersectionality provides a lens through which researchers can elucidate and explain population health disparities across multiple axes of social positions, centering the notion that "social categories are not independent and unidimensional but rather multiple, interdependent, and mutually constitutive" (p. 1268).[22]

Given a dearth of evidence on vaping and vaping disparities among transgender adolescents of color, the present study examines the prevalence of adolescent vaping at the intersection of gender identity and race/ethnicity in a population-based sample of adolescents in California secondary schools. We tested the hypothesis that gender identity and race/ethnicity interact such that transgender adolescents of color (who are dually marginalized within interlocking systems of racism and cisgenderism) would evidence greater frequency of vaping compared to cisgender white adolescents (who are dually privileged within these systems). This information may provide a starting point for advancing understanding of vaping disparities among transgender adolescents of diverse races/ethnicities and informing vaping prevention and control initiatives.

Methods

The data for this study come from the California Healthy Kids Survey (CHKS) collected in 2017–2018 and 2018–2019. One of the largest of its kind in the United States, the CHKS is administered via paper/pencil or electronically to adolescents in California schools on a variety of health domains, including tobacco and substance use, and sociodemographics, including gender identity, ethnicity, and race. School districts receiving subsidies from the California Department of Education (approximately 50% of districts in California) are required to administer the CHKS at least biennially in 7th and 9th grades and are strongly encouraged to administer it in 5th and 11th grades. Districts not receiving subsidies participate voluntarily. Parents/guardians provide active, written consent for children in 5th grade and passive consent (ie, opt-out) for children in 7th grade and above to participate. Student participation is voluntary and anonymous.[24] For years 2017–2018 and 2018–2019, approximately 75% of California school districts administered the survey at least once (n = 743 districts; n = 5591 schools), 39% of which administered it twice (n = 289 districts).[25]

Measures

Our main independent variables were gender identity and race/ethnicity. Gender identity was measured with the question, "Some people describe themselves as transgender when their sex at birth does not match the way they think or feel about their gender. Are you transgender?" We categorized participants into three gender identity categories based on their response to the question: (1) Cisgender ("No, I am not transgender"), (2) Transgender ("Yes, I am transgender"), and Unsure of Gender Identity ("I am not sure if I am transgender"). We categorized race/ethnicity based on participant responses to two separate questions: (1) "Are you of Hispanic or Latino origin" (yes/no), and (2) "What is your race?" (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Pacific Islander, Mixed [two or more] races). Participants who indicated a Hispanic or Latino ethnicity were categorized as "Latinx" (a gender-inclusive label)[26] regardless of the race they endorsed. Participants who did not indicate a Latinx identity were categorized as non-Latinx white (hereafter white), non-Latinx Black or African American (hereafter Black), non-Latinx Asian (hereafter Asian), non-Latinx American Indian or Alaskan Native (hereafter American Indian or Alaskan Native), non-Latinx Native Hawaiian or Pacific

Islander (hereafter Native Hawaiian or Pacific Islander), and non-Latinx multiracial (hereafter multiracial).

Our outcome variable was number of days vaped in the past 30 days, ie, vaping frequency, measured with the item: "During the past 30 days, on how many days did you use electronic cigarettes, e-cigarettes, or other vaping devices such as juul, e-hookah, hookah pens, or vape pens? (Response options: 0 days, 1 day, 2 days, 3–9 days, 10–19 days, and 20–30 days)." Past research on adolescent vaping has tended to examine vaping as a binary outcome (no vs any vaping). To allow for greater detail in modeling frequency, we re-categorized this variable on an integer ordinal scale of 0 days (1 = no use), 1 day (2 = minimal use), 2–9 days (3 = moderate use), and 10 or more days (4 = high use) vaping in the past 30 days.

Based on prior research finding differential patterns in vaping or other tobacco product use among adolescents by specific sociodemographic factors,[10,12] we included the following potential confounders in analyses: grade, parental education, and sexual orientation. We coded grade into four categories to capture typical groupings in the U.S. context and aid model convergence: 6th–8th (middle school), 9th–10th (lower high school), 11th–12th (upper high school), and other/nontraditional. Of note, the majority of adolescents participating in the CHKS are in grades 7th, 9th, and 11th; however, a small proportion of students participating in the 2017–2018 or 2018–2019 survey indicated that they were in 6th, 8th, 10th, or 12th grade which may mean they completed the survey during a class that is primarily open to students in grades 7th, 9th, or 11th, or that their school administered the survey to all grades. We coded parental education into five categories: did not graduate from high school, graduated from high school, attended some college, graduate college, or "don't know," and sexual orientation into six categories: heterosexual/straight, gay/lesbian, bisexual, not sure, other (ie, sexual orientation not listed in available response options), or declined to answer.

Statistical Analysis

Our analytical goal was to test the hypothesis that disparities in vaping frequency would be magnified among transgender adolescents of color relative to cisgender white adolescents. We pooled data from the CHKS 2017–2018 and 2018–2019 waves to increase sample size in smaller racial/ethnic and gender identity subcategories (eg, transgender Native Hawaiian or Pacific Islander adolescents) and to ensure that the maximum number of schools across the state could be included in the analysis given most schools participate biennially as opposed to annually. We restricted analyses to data from adolescents in grades 6th and above (initial sample, n = 1 172 377), as the 5th-grade survey does not ask about gender identity or substance use (including vaping). We excluded data from 26 schools that did not collect gender identity (n = 6012, 0.5% of the initial sample). Compared to adolescents attending schools that collected gender identity, adolescents attending schools that did not collect gender identity were less likely to report any past 30-day vaping (6.6% vs 9.4%; p-value = .0381), and more likely to identify as white (45.0% vs 20.8%; p-value < .0001) and report their parents graduated from college (72.3% vs 39.0%; p-value < .0001). We further excluded observations collected via a shortened version of the survey which lacked items on substance use (n = 47 494, 4.1% of the remaining sample). Per recommendations from the survey administrator WestEd, we then excluded observations considered implausible or impossible responses and/or endorsement of an item indicating that some or all survey items were answered dishonestly (n = 11 606, 1.0% of the remaining sample). We chose not to impute missing data on the outcome or main independent variables and thus excluded 12.8% of the observations in the remaining sample (n = 142 120). Finally, we excluded missing data on covariates (1.2%, n = 11 700 of the remaining sample) due to the small proportion of missing. Our final analytic sample included 953 445 observations (n = 518 929, 54.4% from CHKS 2017–2018 and n = 434 516, 45.6% from CHKS 2018–2019; 81.3% of 1 172 377 original pooled dataset).

First, we examined gender identity and race/ethnicity differences in sociodemographic characteristics via descriptive statistics and calculated bivariate chi-squares accounting for school clustering. Next, we calculated prevalence estimates of vaping frequency by gender identity stratified by race/ethnicity. Because our outcome variable (vaping) met the proportional odds assumption for our independent variables (data not shown), we used generalized linear mixed models for an ordinal outcome to examine bivariate odds ratios (ORs) and multivariable adjusted odds ratios (AORs) and 95% confidence intervals (CIs) estimating associations of gender identity and race/ethnicity with vaping. To examine the joint relationship between gender identity and race/ethnicity in vaping frequency,[27] we formally tested gender identity-by-race/ethnicity statistical interaction (referent categories: cisgender, white), adjusting for covariates. Because we aimed to examine the relationship between two independent variables and an outcome,[28] we estimated two models: one quantifying relationships between gender identity (referent: cisgender) and vaping within race/ethnicity strata and another quantifying relationships between race/ethnicity (referent: white) and vaping within gender identity strata. Generalized linear mixed models included random intercepts at level two to account for correlations among adolescents nested in schools. Models were fitted by maximum likelihood with Laplace approximation[29] in SAS version 9.4. The San Diego State University Institutional Review Board deemed our analysis of publicly available, de-identified data, exempt from review.

Results

Most adolescents in the analytic sample were cisgender (97%); 0.92% were transgender, and 1.73% were unsure of their gender identity. Table 1 provides sociodemographic characteristics of the sample overall and by gender identity. Participants were diverse in terms of their race/ethnicity, with Latinx adolescents making up more than half of the sample (52%), followed by white (22%), Asian (11%), multiracial (10%), Black (3%), Native Hawaiian or Pacific Islander (1%), and American Indian or Alaskan Native (1%) adolescents. Chi-square tests revealed statistically significant associations between independent variables (gender identity, race/ethnicity) and grade, parental education, and sexual orientation (ps < .0001; data not shown). The prevalence of any past 30-day vaping for the full sample was 8.6%. As a point of comparison, the prevalence of any past 30-day combustible cigarette smoking was 1.7% for the full sample.

Table 2 presents the distributions of vaping frequency in the past 30 days by gender identity and bivariate associations between gender identity and vaping frequency, each within race/ethnicity strata. For each race/ethnicity stratum, transgender adolescents evidenced greater odds of more days vaping relative to their cisgender peers (ps < .0001). Associations for adolescents unsure of their gender identity were less consistent, with only Latinx, Asian, and Black adolescents

Table 1. Sociodemographic Characteristics of Participants by Gender Identity, California Healthy Kids Survey, 2017–2018, 2018–2019 (N = 953 445)

Characteristic	Total	Cisgender	Transgender	Unsure
	N = 953 445, n (%)	N = 928 149, n (%)	N = 8762, n (%)	N = 16 534, n (%)
Race/ethnicity				
Hispanic or Latinx ("Latinx")	490 606 (51.5)	478 688 (51.6)	4199 (47.9)	7719 (46.7)
American Indian or Alaskan Native, non-Latinx	9365 (1.0)	8955 (1.0)	140 (1.6)	270 (1.6)
Asian, non-Latinx	104 052 (10.9)	101 257 (10.9)	579 (6.6)	2216 (13.4)
Black or African American, non-Latinx	32 568 (3.4)	31 712 (3.4)	367 (4.2)	489 (3.0)
Native Hawaiian or Pacific Islander, non-Latinx	11 566 (1.2)	11 261 (1.2)	127 (1.5)	178 (1.1)
Multiracial (2 or more races), non-Latinx	97 235 (10.2)	93 916 (10.1)	1095 (12.5)	2224 (13.5)
White, non-Latinx	208 053 (21.9)	202 360 (21.8)	2255 (25.7)	3438 (20.8)
Grade				
6th–8th	335 194 (35.2)	324 715 (35.0)	2512 (28.7)	7967 (48.2)
9th–10th	322 762 (33.9)	314 571 (33.9)	3270 (37.3)	4921 (29.8)
11th–12th	271 413 (28.5)	265 531 (28.6)	2585 (29.5)	3297 (19.9)
Nontraditional	24 076 (2.5)	23 332 (2.5)	395 (4.5)	349 (2.1)
Parental education				
Did not graduate from high school	125 727 (13.2)	122 517 (13.2)	1247 (14.2)	1963 (11.9)
Graduated high school	150 401 (15.8)	146 742 (15.8)	1440 (16.4)	2219 (13.4)
Some college	120 403 (12.6)	117 290 (12.6)	1219 (13.9)	1894 (11.5)
Graduated college	383 874 (40.3)	374 552 (40.4)	3284 (37.5)	6038 (36.5)
Do not know	173 040 (18.2)	167 048 (18.0)	1572 (17.9)	4420 (26.7)
Sexual orientation				
Heterosexual/straight	801 018 (84.0)	795 760 (85.7)	1691 (19.3)	3567 (21.6)
Gay/lesbian	14 833 (1.6)	11 464 (1.2)	1944 (22.2)	1425 (8.6)
Bisexual	52 396 (5.5)	46 506 (5.0)	2220 (25.3)	3670 (22.2)
Not sure	43 427 (4.6)	37 549 (4.1)	730 (8.3)	5038 (30.5)
Other	14 071 (1.5)	10 186 (1.1)	1815 (20.7)	2070 (12.5)
Decline to answer	27 700 (2.9)	26 574 (2.9)	362 (4.1)	764 (4.6)
Any past 30-day vaping				
No	871 664 (91.4)	849 596 (91.5)	7095 (81.0)	14 973 (90.6)
Yes	91 781 (8.6)	78 553 (8.5)	1667 (19.0)	1561 (9.4)
Any past 30-day smoking				
No	927 361 (97.3)	904 035 (97.4)	7706 (88.0)	15 620 (94.5)
Yes	16 426 (1.7)	14 791 (1.6)	909 (10.4)	726 (4.4)
Missing	9658 (1.0)	9323 (1.0)	147 (1.7)	188 (1.1)

Percentages are by column and sum to 100% except for rounding error.

evidencing greater odds of more days vaping than their cisgender peers of the same race/ethnicity (ps < .01).

All race/ethnicity by gender identity interactions were significant for transgender adolescents of color relative to cisgender white adolescents (ps < .01), and four out of six interactions were significant for adolescents of color unsure of their gender identity relative to cisgender white adolescents (ps < .05; data not shown). Thus, AORs and 95% CIs of vaping in relation to gender identity within race/ethnicity strata, and race/ethnicity within gender identity strata are presented in Tables 3 and 4, respectively.

Table 3 presents the AORs of vaping frequency for transgender adolescents and adolescents unsure of their gender identity relative to their cisgender peers of the same race/ethnicity. Transgender adolescents evidenced greater odds of more frequent vaping in the past 30 days compared to cisgender adolescents across each race/ethnicity stratum (p-values < .003). AORs ranged from 1.20 among transgender white adolescents to 6.05 among transgender Black adolescents relative to their cisgender peers of the same race/ethnicity.

Patterns were less consistent for adolescents unsure of their gender identity. Compared to cisgender adolescents of the same race/ethnicity, Asian, Latinx, and Black adolescents unsure of their gender identity evidenced approximately 1.34, 1.43, and 3.28 times greater odds of more frequent vaping, respectively. In contrast, white adolescents unsure of their gender identity evidenced lower odds than cisgender white adolescents.

Table 4 presents the AORs of vaping frequency for Latinx, American Indian or Alaskan Native, Asian, Black, Native Hawaiian or Pacific Islander, and multiracial adolescents for each gender identity stratum relative to white adolescents of the same gender identity. Cisgender Latinx, Asian, Black, and multiracial adolescents evidenced lower odds of more frequent vaping relative to cisgender white adolescents. A reverse pattern appeared for transgender adolescents of color, however, such that transgender Latinx, American Indian or Alaskan Native, Black, Native Hawaiian or Pacific Islander, and multiracial adolescents evidenced greater adjusted odds of more frequent vaping relative to transgender white adolescents. For adolescents unsure of their gender identity, patterns were less consistent. Whereas Latinx, Black, and Native Hawaiian or Pacific Islander adolescents unsure of their gender identity evidenced greater odds of more days vaping relative to white adolescents unsure of their gender identity, Asian adolescents unsure of their gender identity evidenced lower odds of more days vaping than white adolescents unsure of their gender identity.

Table 2. Bivariate Associations Between Gender Identity and Vaping Frequency in the Past 30 Days Within Racial/Ethnic Strata Among Adolescents Participating in the California Healthy Kids Survey (2017–2018, 2018–2019)

	Gender identity													
	Cisgender (REF)				Transgender					Unsure				
Race/Ethnicity	0 Days, *n* (%)	1 Day, *n* (%)	2–9 Days, *n* (%)	10+ Days, *n* (%)	0 Days, *n* (%)	1 Day, *n* (%)	2–9 Days, *n* (%)	10+ Days, *n* (%)	OR (95% CI)	0 Days, *n* (%)	1 Day, *n* (%)	2–9 Days, *n* (%)	10+ Days, *n* (%)	OR (95% CI)
Hispanic or Latinx ("Latinx")	438 130 (91.5)	13 940 (2.9)	17 065 (3.6)	9553 (2.0)	3318 (79.0)	264 (6.3)	395 (9.4)	222 (5.3)	2.75 (2.55–2.97)	6853 (88.8)	270 (3.5)	391 (5.1)	205 (2.7)	1.50 (1.40–1.61)
American Indian or Alaskan Native, non-Latinx	8125 (90.7)	241 (2.7)	312 (3.5)	275 (3.1)	108 (77.7)	10 (7.1)	18 (12.9)	4 (2.9)	2.95 (1.89–4.61)	246 (91.1)	6 (2.2)	12 (4.4)	6 (2.2)	1.04 (0.66–1.64)
Asian, non-Latinx	97 540 (96.3)	1283 (1.3)	1422 (1.4)	1012 (1.0)	502 (86.7)	23 (4.0)	32 (5.5)	22 (3.8)	4.05 (3.14–5.22)	2125 (95.9)	25 (1.1)	48 (2.2)	18 (0.8)	1.36 (1.09–1.70)
Black or African American, non-Latinx	30 041 (94.7)	576 (1.8)	696 (2.2)	399 (1.3)	261 (71.1)	33 (9.0)	48 (13.1)	25 (6.8)	7.36 (5.75–9.41)	417 (85.3)	23 (4.7)	30 (6.1)	19 (3.9)	3.00 (2.26–3.88)
Native Hawaiian or Pacific Islander, non-Latinx	10 196 (90.5)	311 (2.8)	463 (4.1)	291 (2.6)	92 (72.4)	9 (7.1)	15 (11.8)	11 (8.7)	3.86 (2.57–5.81)	157 (88.2)	4 (2.3)	10 (5.6)	7 (3.9)	1.30 (0.81–2.10)
Multiracial, non-Latinx	86 009 (91.6)	2348 (2.5)	3084 (3.3)	2476 (2.6)	922 (84.2)	52 (4.8)	61 (5.6)	60 (5.5)	1.93 (1.63–2.29)	2061 (92.7)	45 (2.0)	65 (2.9)	53 (2.4)	0.97 (0.82–1.14)
White, non-Latinx	179 555 (88.7)	5884 (2.9)	8507 (4.2)	8414 (4.2)	1891 (83.9)	83 (3.7)	157 (7.0)	123 (5.5)	1.41 (1.26–1.60)	3114 (90.6)	83 (2.4)	125 (3.6)	116 (3.4)	0.93 (0.83–1.05)

CI = confidence interval; OR = odds ratio.

Percentages are by row within each racial-ethnic stratum and sum to 100% except for rounding error; generalized linear mixed models for an ordinal outcome assess greater number of days vaping in the past 30 days accounting for clustering at the school level; cisgender adolescents = referent group.

Discussion

Consistent with our hypothesis, we found that gender identity and race/ethnicity significantly interacted in their association in vaping frequency such that transgender adolescents of color were generally more likely to report a higher frequency of vaping compared to cisgender white adolescents. Although less consistent, some groups of adolescents of color who were unsure of their gender identity were also disproportionately more likely to report a higher frequency of vaping compared to cisgender white adolescents.

In stratified models, we observed disparities in vaping frequency between transgender and cisgender adolescents within each race/ethnicity stratum as well as in vaping frequency among transgender Latinx, American Indian and Alaskan Native, Black, Native Hawaiian or Pacific Islander, and multiracial relative to their transgender white peers. The largest differences in both stratified models were among transgender Black adolescents who evidenced 6 times the odds of more frequent vaping relative to their cisgender Black peers and nearly 3 times the odds of more frequent vaping relative to their transgender white peers. In the model stratified by gender identity, we observed reversed patterns among cisgender adolescents, with white adolescents evidencing greater odds of more frequent vaping than their cisgender peers of color.

Taken together, our findings extend past research documenting vaping and other tobacco use disparities among transgender relative to cisgender youth[9–13] to highlight pronounced disparities in vaping frequency among transgender adolescents of color. Our finding of gender identity disparities in vaping frequency among Black adolescents, in particular, aligns with a recent analysis of data from the 2018–2019 Behavioral Risk Factor Surveillance System finding that transgender Black adults were more likely to be current smokers relative to cisgender Black adults.[30] Additionally, our finding that cisgender adolescents of color tended to vape less frequently than their cisgender white peers is in keeping with prior research documenting greater prevalence of vaping among white adolescents compared to their Black and Latinx peers.[8]

Our study does not explain the reasons for the observed disparities in vaping frequency; however, structural injustice (eg, structural racism) has been identified as a fundamental cause of health disparities.[31,32] Structural injustice is enforced via inequitable sociopolitical and economic systems and norms that differentially influence access to resources and opportunities (eg, housing, health care, money) for groups based on relative societal power, and in turn, health behaviors and outcomes.[33] Interpreting our findings through this understanding of structural injustice, gender minority stress,[16] and intersectionality[22,23] suggests multilevel discrimination and stressors may drive the observed disparities in vaping frequency among transgender adolescents of color. Transgender youth of color face pronounced housing instability, employment precarity, lack of access to health care, and violence and victimization,[34,35] which may lead to vaping as a coping strategy. Qualitative research with racially/ethnically diverse LGBTQ youth smokers (including studies prior to the emergence of vape products and studies inclusive of vape products) have found that participants describe smoking as a way to deal with stress and take back control from or rebel against oppressive systems.[17,36]

Limited supportive resources in schools may also underlie disparities in vaping among transgender adolescents of color. For example, participation in LGBTQ empowerment groups, ie, Gender

Table 3. Multivariable Associations Between Gender Identity and Vaping Frequency in the Past 30 Days Within Racial/Ethnic Strata Among Adolescents Participating in the California Healthy Kids Survey (2017–2018, 2018–2019)

	Race/ethnicity													
	Hispanic or Latinx ("Latinx")		American Indian or Alaskan Native, non-Latinx		Asian, non-Latinx		Black or African American, non-Latinx		Native Hawaiian or Pacific Islander, non-Latinx		Multiracial, non-Latinx		White, non-Latinx	
Gender identity	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Cisgender (REF)	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Transgender	2.42 (2.23–2.62)	<.0001	2.44 (1.61–3.72)	<.0001	3.46 (2.70–4.45)	<.0001	6.05 (4.76–7.68)	<.0001	3.22 (2.14–4.85)	<.0001	1.62 (1.37–1.93)	<.0001	1.20 (1.06–1.35)	0.0033
Unsure	1.43 (1.32–1.54)	<.0001	1.04 (0.66–1.63)	0.8655	1.34 (1.08–1.66)	0.0084	3.28 (2.53–4.26)	<.0001	1.39 (0.87–2.21)	0.1634	0.90 (0.76–1.06)	0.1930	0.83 (0.73–0.93)	0.0020

AOR = adjusted odds ratio; CI = confidence interval.

Generalized linear mixed models for an ordinal outcome assess greater number of days vaping in the past 30 days, include race/ethnicity by gender identity interaction terms, and account for clustering at the school level simultaneously; cisgender adolescents = referent group; model adjusts for potential confounding of grade, parental education, and sexual orientation.

Sample interpretation of the AORs from the generalized linear mixed model for an ordinal outcome presented in Table 3: "Compared to their *cisgender Latinx* peers, *transgender Latinx* adolescents evidenced 2.42 times the odds of more frequent vaping in the past 30 days."

and Sexuality Alliances (GSAs), is associated with lower levels of school-based victimization[37] and greater receptivity to school-based substance use prevention efforts among LGBTQ adolescents.[38] However, there are several limitations to effective engagement of transgender adolescents and adolescents of color within GSAs, including limited considerations of or discussions regarding diverse gender identities and intersections of LGBTQ identities with race, ethnicity, and socioeconomic position among members.[39,40] If GSAs or other LGBTQ-specific resources in schools are not inclusive of or welcoming to youth with diverse gender identities or race/ethnicities, the potential for these resources to buffer against stress and/or prevent vaping (as well as other substance use) may be inequitably distributed. Additionally, the enduring history of predatory marketing of tobacco and vape products to youth[41,42] may influence vaping disparities among transgender adolescents of color. A recent study found LGBTQ adolescents and Black and Latinx adolescents reported higher engagement with online tobacco and e-cigarette marketing compared to their non-LGBTQ and white peers, respectively.[43]

A final note about interpreting the study's findings is warranted. One might conclude that gender identity (or, cisgenderism), as opposed to race/ethnicity (or, racism), contributes more to disparities in vaping among transgender/unsure adolescents of color because the magnitude of these disparities is larger within race/ethnic groups than across race/ethnic groups. We caution against such an interpretation, as this logic contradicts the notion that systems of power are intersecting and interlocking; thus, identities or social positions cannot be neatly disentangled.[22,44] Instead, we call attention to the increased vulnerability for higher vaping frequency among transgender adolescents of color with the framework of intersectionality in mind, and the need for future research to examine and intervene on the interlocking systems shaping these disparities.

Limitations and Strengths

Our study should be considered within the context of its limitations. Our sample consists of adolescents in secondary schools in one U.S. state (California); the extent that findings generalize to adolescents in California and more broadly is uncertain. Additionally, there is variability in the terms used by transgender and gender diverse people to describe their gender identity.[45] Thus, our categories may not reflect the diversity of participants' gender identities or be culturally sensitive to gender identities among adolescents within particular racial/ethnic groups, such as American Indian or Alaskan Native adolescents who may identify as two-spirit or other gender identities not assessed in the CHKS.[46] A similar concern relates to our measurement of race and ethnicity which we combined as race/ethnicity, leading to categorization of more than half the sample as Latinx (which is considered an ethnicity rather than a race in the U.S. context). Although this approach to measurement is common, our failure to disentangle ethnicity from race may have masked nuanced disparities among Latinx adolescents who also identify with a specific race (not all do), for example, Afro-Latinx adolescents.[47] We were also are unable to determine precisely the substances vaped by participants as the survey did not measure substances vaped (eg, nicotine vs cannabis), however, the CHKS item is preceded by questions about past 30-day smoking and use of smokeless tobacco (suggesting that the item is assessing vaping nicotine); other types of substance use (eg, cannabis) are asked about separately. Finally, we did not test causal mechanisms of the observed vaping disparities. At best, our independent variables of race/ethnicity and gender identity

Table 4. Multivariable Associations Between Race/Ethnicity and Vaping Frequency in the Past 30 Days Within Gender Identity Strata Among Adolescents Participating in the California Healthy Kids Survey (2017–2018, 2018–2019)

	Gender identity					
	Cisgender		Transgender		Unsure	
Race/ethnicity	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
White, non-Latinx (REF)	1.00		1.00		1.00	
Hispanic or Latinx ("Latinx")	0.91 (0.89–0.93)	<.0001	1.83 (1.59–2.10)	<.0001	1.56 (1.36–1.80)	<.0001
American Indian or Alaskan Native, non-Latinx	1.03 (0.95–1.11)	0.4725	2.09 (1.36–3.23)	0.0008	1.29 (0.82–2.04)	0.2698
Asian, non-Latinx	0.41 (0.39–0.42)	<.0001	1.18 (0.90–1.55)	0.2415	0.66 (0.52–0.84)	0.0009
Black or African American, non-Latinx	0.56 (0.53–0.60)	<.0001	2.85 (2.20–3.70)	<.0001	2.24 (1.69–2.97)	<.0001
Native Hawaiian or Pacific Islander, non-Latinx	1.00 (0.94–1.07)	0.9229	2.70 (1.78–4.11)	<.0001	1.69 (1.05–2.71)	0.0305
Multiracial, non-Latinx	0.95 (0.92–0.97)	0.0001	1.28 (1.05–1.58)	0.0171	1.03 (0.84–1.26)	0.8115

AOR = adjusted odds ratio; CI = confidence interval.

Generalized linear mixed models for an ordinal outcome assess greater number of days vaping in the past 30 days, include race/ethnicity by gender identity interaction terms, and account for clustering at the school level simultaneously; white non-Latinx adolescents = referent group; model adjusts for potential confounding of grade, parental education, and sexual orientation.

Sample interpretation of the AORs from the generalized linear mixed model for an ordinal outcome presented in Table 4: "Compared to their *transgender white* peers, *transgender Latinx* adolescents evidenced 1.83 times the odds of more frequent vaping in the past 30 days."

are proxies for the inequitable systems of power that shape health determinants and outcomes.[48,49]

A key strength is our use of a large, diverse, methodologically strong, population-based sample of adolescents in schools. Our study is strengthened by examining vaping disparities with three categories of gender identity and seven categories of race/ethnicity—yielding detailed information for multiple racial/ethnic groups of transgender adolescents and adolescents unsure of their gender identity. Although some of our analytic categories were relatively small (eg, transgender Native Hawaiian or Pacific Islander adolescents), these findings offer insights into vaping disparities for subgroups often left out or obscured in research and highlight their unique health-related needs. Finally, our use of an ordinal model to assess disparities in vaping frequency is a strength, as more frequent vaping may be more harmful than infrequent vaping.

Implications for Future Research

Our findings have implications for future research, including the need to examine the multilevel causal mechanisms of adolescent vaping disparities at the intersection of gender identity and race/ethnicity. Explicit examinations of how systems of power intersect to shape disparities are necessary to mitigate inequitable population-level differences in health behaviors and outcomes.[50] Thus, future research on vaping disparities among transgender and other marginalized communities of young people should employ novel and community-engaged approaches that identify and interrogate these systems. Mixed methods community-based participatory research (MM-CBPR) is one such approach. In MM-CBPR, researchers collaborate directly with communities to gather and synthesize both qualitative and quantitative data to generate locally valid results and catalyze action for social change and sustainable health improvements. In the context of adolescent health disparities prevention, this approach may be especially useful for identifying and/or implementing asset-based and youth-led interventions.[51] For example, researchers could directly partner with teachers, service providers, parents, and transgender adolescents of color to gather insights based on survey data and in-depth interviews or focus groups into the individual, interpersonal, and contextual factors that influence adolescent vaping. Indeed, research has found that supportive school, community-based, and family contexts may buffer against substance use and support well-being among transgender adolescents[52]—MM-CBPR is well suited to examine these influences and identify multiple levers for intervention. There is also a need to examine gender identity disparities in adolescent vaping and co-use of tobacco products, such as combustible cigarettes. While explorations of vaping alone are important given recent increases in vaping prevalence, examinations of co-use and the health effects of co-use relative to vaping alone should be prioritized for prevention planning.

Conclusion

Our study identified pronounced disparities in adolescent vaping frequency among transgender adolescents of color in California secondary schools, highlighting an important priority group for vaping prevention and control initiatives. Future research should leverage intersectional frameworks coupled with a variety of methodological approaches to examine and intervene on the causal mechanisms undergirding adolescent vaping disparities at the intersections of gender identity and race/ethnicity.

Supplementary Material

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

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Declaration of Interests

We have no interests to declare.

Data Availability

Data access can be arranged with the California Healthy Kids Survey Administrator: https://calschls.org

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