Ethnic Differences in Patterns of Cigarette and E-cigarette Use over Time Among Adolescents

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Abstract

Background: Little is known about whether adolescent cigarette and e-cigarette use patterns over time differ by ethnicity.

Methods: Data were pooled from three prospective cohort studies of adolescents in California and Connecticut (baseline:2013–2014; 12-month follow-up:2014–2015; *N*=6258). Adjusted polytomous regression models evaluated the association of baseline exclusive ever e-cigarette use, exclusive ever cigarette use, ever use of both e-cigarettes and cigarettes (dual use) with past 30-day use at follow-up (exclusively e-cigarettes, exclusively cigarettes, dual use; no use at baseline/follow-up were the referent groups. Interaction analyses evaluated differences by race/ethnicity (Hispanic White [HW], non-Hispanic White [NHW], Other).

Results: A significant global interaction was observed for the association of baseline with follow-up tobacco use by ethnicity (p=0.009). Among NHW participants, ever e-cigarette or cigarette users at baseline (vs. never users) had significantly higher odds of every past-30 day use tobacco use pattern at follow-up. Among HW participants, compared with never users, exclusive e-cigarette users at baseline had increased odds of continued e-cigarette use ($OR_{exclusive\ e-cigarettes}$=5.22; 95%CI:3.50,7.79; $OR_{dual\ use}$=3.64; 95%CI:1.62,8.18) but not of

transition to exclusive cigarette use at follow-up ($OR_{exclusive\ cigarettes}$=1.27; 95%CI:0.47,3.46), and HW exclusive cigarette users at baseline had greater odds of continued cigarette use ($OR_{exclusive\ e-cigarettes}$=12.3; 95%CI:5.87,25.8; $OR_{dual\ use}$=3.82; 95%CI:1.06,13.7) but not of transition to exclusive e-cigarette use at follow-up ($OR_{exclusive\ cigarettes}$=1.61; 95%CI:0.62,4.18).

Conclusions: Findings that NHW youth report more transitional use patterns and HW youth report more stable use patterns suggest a potential for differential impacts of e-cigarettes, by ethnicity, in increasing subsequent transition to or cessation from cigarette smoking.

Keywords

e-cigarette; cigarette; ethnicity; tobacco use; transitions; adolescents

INTRODUCTION

Over the past 50 years, there has been a widening gap in the disparities in tobacco use for certain racial/ethnic groups relative to the general population.[1] While the overall rate of current (past 30-day) cigarette smoking has decreased over time among youth, the literature examining whether such declines differ by ethnicity are mixed. Some data show that non-Hispanic White youth are experiencing a greater decline in smoking rates than Hispanic White youth,[2–5] while other data show similar patterns of decline for both ethnic groups for current (past 30-day),[3,6–8] and current daily[1,9] smoking. In adolescence and early adulthood, Hispanic White youth are more likely to be intermittent current cigarette smokers than daily current smokers.[1] However, Hispanic White individuals are also less likely to receive advice to quit from a healthcare professional and are more likely to have reduced access to smoking cessation treatments, because they have less healthcare access and lower health insurance coverage; Hispanic Whites are also more likely to relapse following a cessation attempt relative to non-Hispanic Whites.[1,10–12]

The increasing variety of tobacco products in recent years has raised concerns about the proliferation of tobacco-related health disparities by ethnicity that may arise due to disproportionate initiation of non-cigarette tobacco products in adolescence, and the risk of transition to combustible cigarette use.[13–18] More recently, with the increase in popularity of e-cigarettes, use of e-cigarettes and multiple tobacco products have become more prevalent in Hispanic White (vs. non-Hispanic White) youth in some adolescent age groups.[3,6,7,19,20] Prior work suggests that various tobacco products may be advertised and promoted disproportionately among Hispanic White communities,[21] and Hispanic White youth may perceive tobacco products as less dangerous than non-Hispanic White youth.[22] Thus, if e-cigarettes are drawing more Hispanic White youth to tobacco product use, and such youth then initiate combustible cigarette use, Hispanic White populations may begin to experience a greater overall burden of tobacco-related disease relative to non-Hispanic White populations. On the other hand, an increased pattern of transition from cigarettes to e-cigarettes could result in a lower risk of the adverse health consequences of tobacco product use in this population if e-cigarettes are eventually determined to be a less harmful alternative to combustible cigarette use. Understanding the pattern of ethnic-specific tobacco-product use and the associated transitions between e-cigarettes and cigarettes is necessary to develop appropriate prevention and regulation.

In the current study, we used data from three prospective cohort studies of youth in California and Connecticut to examine patterns of tobacco use at baseline and follow-up approximately one year later, by ethnicity.

METHODS

Participants

Data were pooled from three cohorts of adolescents and young adults from the University of Southern California and Yale University Tobacco Centers of Regulatory Science (TCORS), including the Southern California Children's Health Study (CHS),[23,24] Happiness & Health Project (H&H),[13] and Yale Adolescent Survey Study (YASS),[25,26] as described previously.[27] In the current study, we used data from Fall 2013-Spring 2015 (baseline) and follow-up data collected in each study approximately one year later to investigate transitions between single and dual product use by ethnicity. This study was approved by both the University of Southern California Institutional Review Board and the Yale University Institutional Review Board.

Measures

E-cigarette and Cigarette Use: At each survey, participants were asked the age at first use of cigarettes. Participants who had "never tried" a cigarette (not "even one or two puffs") were classified as "never users". Those reporting an age at first use of cigarettes were classified as "ever users" of cigarettes. For CHS and H&H, an analogous series of questions was used to classify e-cigarette use. For YASS, ever use of e-cigarettes was determined based on an affirmative response to a question asking if the participant had ever tried e-cigarettes. At follow-up, participants were additionally asked the number of days cigarettes were used in the past 30 days (0, 1–2, 3–5, 6–9,10–19, 20–29, or all 30 days), and the number of days e-cigarettes were used in the past 30 days. Participants who reported use of e-cigarettes, but not cigarettes, in the past 30 days were classified as "exclusive e-cigarette users," participants who reported use of cigarettes, but not e-cigarettes, in the past 30 days were classified as "exclusive cigarette users," and participants who reported use of both products in the past 30 days were considered "dual product users."

Sociodemographic characteristics: Questionnaires assessed race/ethnicity (Hispanic White, non-Hispanic White, Other [i.e., Asian/Pacific Islander, African American, Native American/Alaska Native, Multiracial]), gender, baseline grade in high school (9th, 10th, 11th, 12th), and parental education (less than high school, high school graduate, some college or college degree; available only in CHS and H&H).

Statistical Analysis

Based on prospectively collected data, we used polytomous logistic regression models to evaluate the association of baseline ever tobacco use (exclusive e-cigarette use, exclusive cigarette use, dual product use) with past 30-day use at follow up (exclusive e-cigarette use, exclusive cigarette use, dual product use); for all analyses, never users at baseline served as the exposure referent group and no past 30-day use at follow-up served as the outcome referent group. We evaluated a global interaction across all exposures and outcomes by race/

ethnicity (non-Hispanic White, Hispanic White, Other) in the entire sample, including product interaction terms for each race/ethnicity × tobacco use baseline exposure variable. Sample size was not large enough to test additional racial groups within the "other" category. Additional analyses evaluated a global interaction in models restricted to non-Hispanic White and Hispanic White participants; interaction p-values were negligibly different. Models were stratified by ethnicity (non-Hispanic White/Hispanic White) to report ethnic-specific effects. Post-hoc tests were used to evaluate whether effect estimates for each outcome vs. the reference group (no past 30-day use) were significantly different from one another, by baseline product use. All models were adjusted for gender, grade, and cohort (CHS, H&H, YASS), using a missing indicator where appropriate, with a random effect for school (H&H/YASS) or community (CHS). In sensitivity analyses, we restricted the sample to CHS and H&H and additionally adjusted for parental education. Additional sensitivity analyses to look at past 30 day use at baseline as a predictor of past 30 day use at follow-up were not possible as baseline past 30-day e-cigarette use was not available in H&H, and the sample size by ethnicity was too small when restricted to CHS and YASS. For all analyses, we assessed whether associations varied across cohorts using cohort × baseline tobacco product interaction terms. All statistical analyses were based on two-sided hypotheses tested at a 0.05 level of significance. Analyses were performed using SAS 9.4.

RESULTS

The three studies included slightly more females than males (Table 1). In the CHS and H&H studies, just under 50% of the study sample was Hispanic White; in the YASS, approximately 5% of the study sample was Hispanic White. The CHS included participants in grades 11–12 at baseline; H&H included participants in grade 9 at baseline; YASS included participants in grades 9–12 at baseline. No differences in gender, race/ethnicity, or grade were observed for participants who did (vs. did not) complete questionnaire items on cigarette and e-cigarette use at follow-up; YASS had slightly more participants who did not complete questions (8.0%) and CHS had slightly fewer participants who did not complete questions (5.4%) than H&H (6.3%) (Supplemental Table 1).

At baseline, the prevalence of ever use of any e-cigarette/cigarette use pattern (i.e., exclusive e-cigarette use, exclusive cigarette use, or dual product use) was higher for Hispanic White participants (34.5%) than for non-Hispanic White participants (24.9%; p<0.001; Table 2). Among non-Hispanic White participants, 11.3% reported exclusive ever e-cigarette use, 2.5% reported exclusive ever cigarette use, and 11.1% reported ever use of both products. Among Hispanic White participants, 17.0% reported exclusive ever e-cigarette use, 4.5% reported exclusive ever cigarette use, and 13.0% reported ever use of both products. At follow-up, non-Hispanic White participants were more likely to report past 30-day use of any tobacco product relative to Hispanic White participants (17.3% vs. 13.2%; p<0.001). Among non-Hispanic White participants, 8.5% reported exclusive past 30-day use of e-cigarettes, 3.1% reported exclusive past 30-day use of cigarettes, and 5.6% reported dual past 30-day use. Among Hispanic White participants, 6.9% reported exclusive past 30-day use of e-cigarettes, 2.8% reported exclusive past 30-day use of cigarettes, and 3.5% reported past 30-day dual product use.

Descriptive analyses of patterns of follow-up cigarette or e-cigarette use, by strata of baseline use pattern, also differed by ethnicity (Figure 1A and B, Table 3). Among non-Hispanic White participants, those who reported no use, exclusive e-cigarette use, or exclusive cigarette use at baseline were more likely to report exclusive e-cigarette use at follow-up, relative to exclusive cigarette or dual product use at follow-up (Figure 1A). Among Hispanic White participants, baseline exclusive cigarette users were more likely to report exclusive past 30-day cigarette use at follow-up than either exclusive cigarette or dual product use (Figure 1B).

Descriptively, the associations between baseline tobacco use and past 30-day use at follow-up were stronger among non-Hispanic White participants than among Hispanic White participants, with one exception (OR for past 30-day exclusive cigarette use among baseline cigarette users). We found a statistically significant global interaction by ethnicity (p-value = 0.009). In addition, for each outcome (vs. no past 30-day use), we observed differences by ethnicity (interaction p-value for the outcome of exclusive e-cigarette vs. no use=0.064; interaction p-value for the outcome of exclusive cigarette vs. no use=0.010; interaction p-value for the outcome of dual vs. no use=0.045; see footnotes to Table 3). In adjusted models, non-Hispanic White participants using any tobacco product at baseline had significantly higher odds of using any product in the past 30-days at follow up. Exclusive e-cigarette users at baseline had higher odds of reporting e-cigarette or dual product use at follow-up than of reporting exclusive cigarette use at follow-up (though differences in ORs were not significant); exclusive cigarette users at baseline had greater odds of reporting dual product use at follow-up than of reporting exclusive use of e-cigarettes; dual users had the greatest odds of remaining dual product users at follow-up. Among Hispanic White participants, exclusive e-cigarette users had higher odds of reporting e-cigarette use or dual product use at follow-up, but no increased odds of reporting exclusive cigarette use at follow-up in adjusted models (relative to non-users; p>0.05). Hispanic White exclusive cigarette users had the highest odds of remaining a cigarette user, and slightly increased odds of reporting dual use at follow-up, but no increased odds of exclusive e-cigarette use at follow-up (relative to non-users). Dual users followed similar patterns to those of non-Hispanic White dual users. Results did not change appreciably in sensitivity analyses restricted to CHS and H&H, with or without additional adjustment for parental education (results not tabulated).

DISCUSSION

Baseline prevalence of ever use of cigarettes or e-cigarettes was higher in Hispanic White participants than in non-Hispanic White participants. In contrast, at follow-up, the prevalence of past 30-day use of cigarettes or e-cigarettes was higher in non-Hispanic White participants than in Hispanic White participants. This finding is consistent with existing literature that suggests that Hispanic White youth are more likely to experiment with tobacco products, but that non-Hispanic White youth are more likely to continue to use traditional tobacco products, especially among older adolescents and in the transition into early adulthood.[8,9,20,28] The difference in current tobacco use rates between Hispanic White and non-Hispanic White populations becomes more pronounced through adulthood, when Hispanic White persons have lower rates of cigarette smoking and e-cigarette use.[8,9,19,20,28]

As such, the tobacco-related disease burden – as it pertains strictly to race/ethnicity – may be reduced in Hispanic White populations as a direct result of lower rates of more regular tobacco use.

However, we found that the patterns of exclusive and dual product e-cigarette and cigarette use at follow-up by strata of baseline use also differed by race/ethnicity, with non-Hispanic White participants demonstrating increased odds of all patterns of recent tobacco use at follow-up while Hispanic White participants exhibited higher odds of stable tobacco use patterns (i.e., using the same product at follow-up as had been used at baseline, rather than switching to a different product). For example, among Hispanic White adolescents, exclusive ever e-cigarette users had the greatest odds (and highest prevalence) of being an exclusive current e-cigarette user and no increased odds of reporting exclusive cigarette use; exclusive ever cigarette users at baseline had the greatest odds (and highest prevalence) of being an exclusive current cigarette user and no increased odds of exclusive e-cigarette use at follow-up. Both exclusive e-cigarette and cigarette users had increased odds of subsequent dual product use, and dual users had the greatest odds (and highest prevalence) of being a current dual product user at follow-up. In contrast, among non-Hispanic White youth, exclusive e-cigarette users at baseline had similar odds of remaining an exclusive e-cigarette user or transitioning to dual product use, and exclusive cigarette users had greater odds of transitioning to dual use than of remaining an exclusive cigarette user or transitioning to exclusive e-cigarette use.

The absence of an association between exclusive ever e-cigarette use at baseline and exclusive recent cigarette use at follow-up among Hispanic White participants is perhaps encouraging, though the potential positive public health implications of this lack of association are tempered by the increased risk of transition from exclusive e-cigarette use to dual product use. On the other hand, the lack of association in the other direction – from exclusive cigarette use to exclusive e-cigarette use – that was observed suggests that Hispanic White participants may potentially disproportionately fail to benefit from any potential utility that e-cigarettes hold as a cessation aid to help smokers quit cigarette use. This could introduce new racial/ethnic disparities in tobacco use patterns over time and increase the burden of tobacco-related disease among Hispanic White populations, if Hispanic White participants continue the use of cigarettes without transition to less harmful products. Further research is needed to understand whether disparities may emerge.

There may be several plausible explanations for the differential patterns of use from baseline to follow-up among Hispanic White (vs. non-Hispanic White) adolescents. Among Hispanic White exclusive cigarette users, continued use of cigarettes and dual use of cigarettes and e-cigarettes at follow up may be influenced by differing perceptions of harm of smoking cigarettes and e-cigarettes among Hispanic White (vs. non-Hispanic White) youth. Prior work has shown that Hispanic White (vs. non-Hispanic White) youth may perceive tobacco products as less dangerous.[22] Hispanic White cigarette smokers may therefore simply continue using cigarettes and have less of an inclination to transition away from combustible cigarette use. A recent study also found that Hispanic White adolescents who have initiated e-cigarettes reported lower perceived harm of e-cigarettes relative to non-Hispanic White adolescent e-cigarette users.[29] Moreover, family substance use has been demonstrated to

impact perceptions of harm and increase risk for smoking among Hispanic White adolescents, such that Hispanic White (vs. non-Hispanic White) youth smokers who had a family member or sibling who used tobacco reported viewing smoking as less harmful and were more likely to be current smokers.[30,31] Therefore, family tobacco use and perceptions of tobacco products and e-cigarettes as being less dangerous and harmful may normalize smoking and vaping behaviors, which may promote continued use of cigarettes or encourage transition to using both products in Hispanic White youth. Furthermore, Hispanic White youth may face several sociocultural stressors, such as acculturative stress and racial discrimination,[32] which may influence continued cigarette use or transition to dual product use at follow-up – Hispanic White youth who are more acculturated to the U.S. are more likely to smoke than their less acculturated counterparts,[33] are twice as likely to try e-cigarettes,[34] and Hispanic White youth who reported more perceived discrimination were more likely to report lifetime and current smoking relative to non-Hispanic Whites.[31] Future research is warranted to further investigate the impact of sociocultural factors and perceptions of harm on patterns of transition between e-cigarette and cigarette use in order to inform possible policy and prevention efforts.

The study is subject to some limitations. There were relatively few youth who reported frequent use of cigarettes or e-cigarettes, so we were unable to evaluate the risk of transitions to higher or lower frequency of past 30-day use of cigarettes, e-cigarettes, or dual product use. Because H&H did not have baseline data available on past 30-day e-cigarette use at baseline, analyses were only able to investigate ever use of either or both products at baseline; sample sizes were too small to do sensitivity analyses of past 30 day use in CHS and YASS. Further, while we were able to evaluate differences by race/ethnicity (Hispanic White vs. Non-Hispanic White participants), we were unable to evaluate whether patterns of association differed for other racial groups (e.g., Asian/Pacific Islander, African American, Native American/Alaska Native) due to insufficient sample size in these groups. Some factors that may influence the transition between products – such as risk taking propensity or impulsivity – were only available in one study; as such, we were unable to adjust for these variables due to low sample size. Finally, the studies represent youth of varying ages in different geographical locations; all analyses were controlled for baseline grade, gender, and study.

This study is the first to examine patterns of e-cigarette and cigarette use over time by race/ethnicity. Further research to examine factors that may influence regional differences in tobacco use transitions in youth could be useful to state and local tobacco control policy makers. Continued research to explore factors that may promote the transition to nicotine dependence – or protect against it –are warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding Source:

Abbreviations:

CHS	Children's Health Study
H&H	Happiness & Health Study
YASS	Yale Adolescent Survey Study
OR	odds ratio
CI	confidence interval

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IMPLICATIONS AND CONTRIBUTION

Differential patterns of e-cigarette and cigarette use at baseline and follow-up were observed by ethnicity, with non-Hispanic White youth reporting more transitional use patterns and Hispanic White youth reporting more stabilizing use patterns. These findings raise concern regarding the impact of e-cigarettes for adolescents of different racial/ethnic backgrounds.

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A) Non-Hispanic White [a]
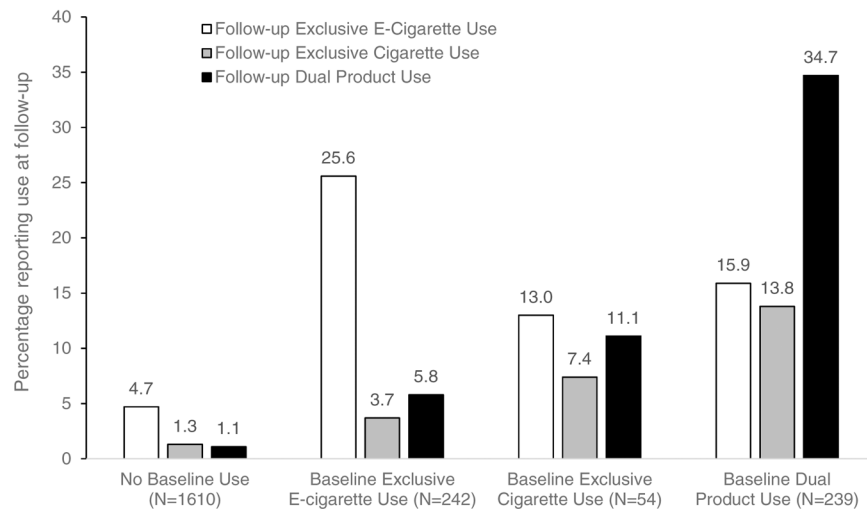
B) Hispanic White [a]
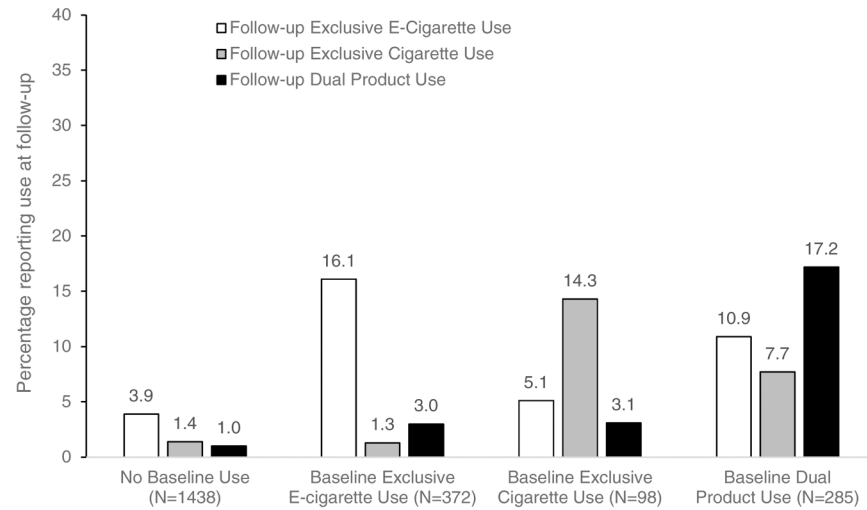
Figure 1.

Prevalence of past 30-day tobacco product use at follow-up, by baseline product use for (A) Non-Hispanic White participants (N=2145), and (B) Hispanic White participants (N=2193)

[a] Proportion reporting no past 30-day use at follow-up is the remaining proportion within each baseline tobacco use group.

Table 1.

Baseline demographic characteristics

	CHS N=1553	HH N=3190	YASS N=1404
	N(%)	N(%)	N(%)
Baseline year of study	Spring 2014	Fall 2015	Fall 2013
Gender			
Male	752 (48.4)	1467 (46.0)	637 (45.4)
Female	801 (51.6)	1723 (54.0)	767 (54.6)
Race/Ethnicity			
NHW	592 (38.1)	512 (16.0)	1198 (85.3)
HW	758 (48.8)	1505 (47.2)	66 (4.7)
Other	203 (13.1)	1173 (36.8)	140 (10.0)
Baseline grade			
9th grade	-	3190 (100.0)	417 (29.7)
10th grade	21 (1.3)		363 (25.9)
11th grade	866 (55.8)		340 (24.2)
12th grade	666 (42.9)		283 (20.2)

[*] Totals may vary due to missing data

NHW = non-Hispanic White

HW = Hispanic White

CHS = Children's Health Study

HH = Happiness & Health Study

YASS = Yale Adolescent Survey Study

Table 2.

Prevalence of Cigarette or E-cigarette Use at Baseline and Follow-up

	NHW	HW	
	N(%)	N(%)	P-value[a]
Baseline (Ever Use)			<0.001
No Use	1610 (75.0)	1438 (65.6)	
Exclusive E-cigarette Use	242 (11.3)	372 (17.0)	
Exclusive Cigarette Use	54 (2.5)	98 (4.5)	
Dual Use	239 (11.1)	285 (13.0)	
Follow-up (Past 30-day Use)			<0.001
No Use	1774 (82.7)	1903 (86.8)	
Exclusive E-cigarette Use	183 (8.5)	152 (6.9)	
Exclusive Cigarette Use	67 (3.1)	61 (2.8)	
Dual Use	121 (5.6)	77 (3.5)	

NHW = non-Hispanic White

HW = Hispanic White

[a]P-value was calculated using chi-squared tests for the difference in cigarette or e-cigarette use patterns by ethnicity.

Table 3.

Ever use of e-cigarettes, cigarettes, or dual product use at baseline and odds of past 30-day use at follow-up

Baseline product ever use	OR (95%CI)[*] for Past 30-day Use at Follow-up		
	Exclusive E-cigarette vs. None[**]	Exclusive Cigarette vs. None[†]	Dual Use vs. None[‡]
Non-Hispanic White			
Neither Product	Ref	Ref	Ref
Exclusive E-cigarette	8.11 (5.53, 11.9) [a]	4.20 (1.87, 9.44) [a]	7.44 (3.63, 15.3)[a]
Exclusive Cigarette	4.05 (1.73, 9.47) [a]	7.66 (2.44, 24.0) [ab]	13.3 (4.96, 35.4) [b]
Dual products	8.66 (5.51, 13.6) [a]	27.6 (15.1, 50.4) [b]	82.1 (47.1, 143.)[c]
Hispanic White			
Neither Product	Ref	Ref	Ref
Exclusive E-cigarette	5.22(3.50, 7.79) [a]	1.27(0.47, 3.46) [b]	3.64 (1.62, 8.18) [ab]
Exclusive Cigarette	1.61 (0.62, 4.18) [a]	12.3(5.87, 25.8) [b]	3.82 (1.06, 13.7) [ab]
Dual products	4.19 (2.61, 6.72) [a]	8.52(4.50, 16.1) [a]	26.9 (14.3, 50.5) [b]

[*] Adjusted for gender; random effect for school or community.

[**] Global p-value for interaction by ethnicity for the outcome of exclusive e-cigarette use vs. no use at follow-up=0.064

[†] Global p-value for interaction by ethnicity for the outcome of exclusive cigarette use vs. no use at follow-up=0.010

[‡] Global p-value for interaction by ethnicity for the outcome of dual use vs. no use at follow-up=0.045

Stability estimates of remaining in a use pattern (vs. non use) are shaded in grey on the diagonal

Superscript letters denote test of independence of effect estimates across each row; estimates sharing letters are not statistically significantly different from one another (p<0.05)