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Protective Factors for Nicotine and Marijuana Vaping Among U.S. Adolescents

Michael J. Parks, PhD[1], **Megan E. Patrick, PhD**[2]

[1]Center for Applied Research and Educational Improvement, University of Minnesota, St. Paul, Minnesota

[2]Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, Michigan

Abstract

Introduction: Nicotine and marijuana vaping among U.S. adolescents are public health priorities. Research has assessed demographic and risk factors related to vaping, but there is a dearth of research on protective factors for vaping. Based on the healthy youth development perspective, the developmental assets framework is used to assess cumulative protective factors and vaping in a national sample of adolescents.

Methods: Data came from the nationally representative Monitoring the Future study, consisting of 12th graders (n=6,982) from the 48 contiguous U.S. states (2017–2019). Past 30–day nicotine and marijuana vaping and developmental assets (low, medium, or high) were examined. Covariates included demographics and other substance use. Weighted descriptive statistics, logistic regression, post-estimation analyses, and multiple imputation were used.

Results: Students with higher assets were less likely to vape nicotine and marijuana, even after adjusting for covariates. The odds of nicotine vaping were lower for students with medium assets (AOR=0.65, 95% CI=0.54, 0.78) and high assets (AOR=0.22, 95% CI=0.16, 0.29) compared with students with low assets. Similarly, the odds of marijuana vaping were lower for youth with medium assets (AOR=0.54, 95% CI=0.42, 0.69) and high assets (AOR=0.09, 95% CI=0.05, 0.18) compared with low assets. Social competence and positive peer norms were strongly protective against both forms of vaping.

Conclusions: The healthy youth development perspective applies to the critical issues of nicotine and marijuana vaping among adolescents. Promoting cumulative assets may help prevent

Address correspondence to: Michael J. Parks, PhD, Center for Applied Research and Educational Improvement, University of Minnesota, 1954 Buford Ave., St. Paul MN 55108. park0614@umn.edu.

Credit Statement

Michael J. Parks: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing – review & editing, Visualization.

Megan E. Patrick: Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition.

vaping among U.S. adolescents, and increasing the specific assets of social competence and positive peer norms could be particularly fruitful.

INTRODUCTION

Nicotine and marijuana vaping among U.S. adolescents are public health priorities. Youth nicotine vaping has reached epidemic proportions,[1-4] and increases risk for cigarette use and poor health outcomes.[5,6] Marijuana vaping markedly increased in 2018 and 2019, and remains relatively high among U.S. adolescents.[2,3] Vaping of tetrahydrocannabinol-containing products is a major concern because of its impact on development, and its link to the recent lung injury epidemic.[1]

Documenting prevalence and predictors of nicotine and marijuana vaping among U.S. adolescents is essential for prevention.[7,8] Yet, there is a dearth of research on factors that protect against vaping; the limited number of studies that have assessed characteristics associated with nicotine and marijuana vaping have focused on demographics and risk factors,[6-8] creating a critical need for research on factors that protect against vaping. Research on adolescent health has experienced a foundational shift away from a risk-based focus to a perspective geared towards promoting well-being and protecting against harm.[9,10] This healthy youth development (HYD) perspective takes a strengths-based focus,[9,11,12] primarily by promoting protective factors that develop strengths, such as competence, confidence, and caring.[9,11,13] There are a range of frameworks within the HYD perspective that identify key protective factors linked to healthy development, and these factors protect against substance use as well.[14,15] No recent research has applied these frameworks and factors to nicotine and marijuana vaping in a national sample of adolescents. This paper utilizes the developmental assets framework (DAF), based on the HYD perspective, which has previously been applied to other substance use such as cigarette smoking, combustible marijuana use, and alcohol use.[16-19] The DAF offers a clear set of measurements and track record for assessing protective factors at the population level,[16,20,21] and emphasizes the importance of cumulative factors rather than prioritizing certain factors.[20,21]

The DAF contends that protective factors can be assessed as internal and external assets, which can be measured dichotomously in order to capture prevalence of low and high levels of assets.[16,21] Internal assets include asset subtypes of social competence, positive identity, commitment to learning, and positive values.[16,21] Social competence concerns decision-making skills such as resistance to peer pressure.[21] Positive identity involves a sense of purpose and satisfaction with life and future.[21] Commitment to learning includes school bonding and school engagement.[21] Positive values are captured via beliefs about equality and social justice, and helping other people.[16] External assets comprise asset subtypes of empowerment, boundaries and expectations, and support.[21] Empowerment measures a sense of safety in one's neighborhood, school, and home.[21] Boundaries and expectations can include positive peer influence, including perceived prevalence of substance use among peers.[21] Support includes receiving support from family, and having positive family communication, as well as feeling supported by neighbors and having a caring neighborhood.[21]

This paper examines protective factors (herein labeled as “assets” in accordance with DAF) by assessing cumulative assets via the DAF. As described in the framework and previous research,[20,21] more assets provide cumulative protection compared with individual protective factors alone. An emerging area of research builds on seminal healthy development research,[22-26] and shows the importance of cumulative assets.[17,20,27,28] Internal assets, such as social competence and positive identity, provide the internal resources and skills for adolescents to successfully navigate away from substance use at a young age; external assets provide the opportunity and resources (relationships, communities) for healthy development.[12,20,21,27] In short, separate assets protect against issues such as substance use by addressing specific areas of an adolescent’s life, and cumulative assets create a context within which adolescents can thrive (e.g., by healthily responding to stress).[12,26,27] Adolescents without these assets are at greater risk to use substances, particularly as a form of coping if they are exposed to stress and adverse experiences.[12,27] Research shows that cumulative assets in childhood and adolescence protect against substance use[19] and mental health problems in adulthood.[20] Those who report low assets experience poorer health and developmental outcomes.[20,28] As yet, this cumulative assets measure has not been applied to vaping in a national sample of adolescents.

METHODS

Study Sample

Data came from the nationally representative Monitoring the Future (MTF) study.[3] The MTF study includes national, repeated cross-sectional samples of 12th graders from the 48 contiguous U.S. states recruited annually. The current MTF sample is a subset of all 12th graders surveyed in 2017–2019 (N=41,737) who completed 1 MTF questionnaire form among 6 randomly distributed questionnaire forms (n=6,982). These years were chosen because the prevalence of vaping increased at a record pace between 2017 and 2019,[29,30] and the single form was chosen because it is the only form that includes protective factor and vaping measures. After removing missing data, the final analytic sample for the primary analyses included 4,590 students. The sample was majority non-Hispanic White (54.3%), followed by 19.5% Hispanic, 11.6% Other, 10.1% non-Hispanic Black, and 4.5% Asian. There were slightly more female participants in the sample (54.6%). This study was approved by the University of Michigan and University of Minnesota IRBs.

Measures

Past 30–day nicotine and marijuana vaping were examined separately. Any past 30–day use is the most common metric for examining current vaping,[3] which was assessed by asking: *On how many days in the past 30 days did you vape nicotine?* and *On how many days in the past 30 days did you vape marijuana?* (recoded to 1=vaped, 0=did not vape).

A total of 9 DAF assets available in the MTF study were examined, including 5 internal and 4 external assets.[16,21] The 9 assets (with DAF asset category labels in parentheses) included decision-making/resistance skills (social competence), life satisfaction (positive identity), sense of self/self-esteem (positive identity), school engagement/school bonding (commitment to learning), values of helping others and equality (positive

values), safe school and neighborhood (empowerment), positive peer norms (boundaries and expectations), perceived support and connection with family (support), and positive neighborhood perceptions (support).

Social competence was assessed based on 2 items that asked: *If one of your best friends were to offer you a cigarette, would you smoke it?* and *If one of your best friends were to offer you a marijuana cigarette, would you smoke it?* (range: 1=*definitely yes* to 4=*definitely no*). The dichotomous cut off corresponded with *definitely no* for both questions (1=*definitely no* for both, 0=other). Research on smoking shows youth who do not report "definitive" resistance are susceptible to smoke,[31] and youth could be more willing to use substances if they report less than *definitely yes*.[32] Positive identity was assessed via a 4-item scale that included questions such as: *How satisfied are you with your life as a whole?* (1=*completely not satisfied* to 7=*completely satisfied*, α=0.84); an average score of greater than *neutral* was used for the cut off.[16] Positive identity also entails a positive sense of self and self-esteem.[21] Positive identity was also assessed via a 2-item scale that included the following questions: *Compared to others your age across the country, how do you rate yourself on school ability?* and *How intelligent do you think you are compared to others your age?* (range: 1=*far below average* to 7=*far above average*, α=0.85). An average score of greater than *average* was used for the cut off.[16]

Commitment to learning was captured via a 5-item scale that included items such as: *How do you feel about going to school?* (range: 1=*I don't like school at all* to 5=*I like it very much*) and *How important do you think the things you are learning in school are going to be for your life?* (range: 1=*not at all important* to 5=*very important*). The standardized scale α was 0.81, and the dichotomous cut off was based on an average score of *quite important/quite a lot* or higher (i.e., ≥4).[16] Positive values were assessed using a 5-item scale that included questions such as: *How important is working to correct social and economic inequalities?* and *How important is making a contribution to society?* (range: 1=*not important* to 4=*extremely important*, α =0.74). The dichotomous cut off was based on an average score of *important* or higher.[16]

Safety was assessed using a 2-question scale that asked how satisfied respondents were with *personal safety in your neighborhood, on your job, and in your school—safety from being attacked and injured in some way and the safety of things you own from being stolen or destroyed in your neighborhood, on your job, or in your school* (range: 1=*completely not satisfied* to 7=*completely satisfied*, α=0.78). The dichotomous cut off was based on an average score of greater than *neutral* (i.e., >4). A 5-item scale was used that captured perceptions of the number of peers that used cigarettes, marijuana, alcohol, e-cigarettes/e-pens, and get drunk once per week (range: 1=none to 5=all, α=0.84). The dichotomous measure for anti-substance use peer influence was based on an average score of *less than some* (i.e., ≤2).

Support was assessed using a single item that asked: *How satisfied are you with the way you get along with your family?* (range: 1=*completely dissatisfied* to 7=*completely satisfied*). The dichotomous cut off was based on anything greater than *neutral* (i.e., ≥5).[16] Support was also assessed by using a single item that asked: *How are satisfied are you with the*

neighborhood where you live? (range: 1=*completely dissatisfied* to 7=*completely satisfied*). The dichotomous cut off was based on a score above *neutral* (i.e., ≥5).

Dichotomous measures were constructed for each asset by determining whether youth possessed a respective asset using the aforementioned cut offs, which corresponded with previous research.[16,21] Creating dichotomous measures from continuous scales loses variability,[16] but there was good correspondence in prevalence of assets using binary measures compared to measures based on 0.5 SDs above the mean for the continuous distributions. After generating 9 dichotomous variables (representing the 9 assets), a count of the number of assets (range=0–9) was created. A final 3-category variable was generated utilizing an established approach for creating asset categories that captured low, medium, and high levels of assets (1= ≤3 assets, 2= 4–6 assets, 3= ≥7 assets).[16,18,21] This categorical breakdown has high sensitivity, particularly in regards to capturing youth with low and high assets.[16,21] The 3 groups are herein labeled as low (0–3), medium (4–6), and high (7–10).

Covariates included race/ethnicity (White=reference, Black, Hispanic, Asian, Other), sex (1=female, 0=male), a measure of SES (maximum parental education [1=a parent had college degree, 0=no parent had a college degree]); urbanicity (urban=reference, small city, rural); and college plans measured by whether participants had definitive plans to attend a 4-year college (1=definitely plan to attend, 0=other).[33] To account for possible geographic differences such as state marijuana laws, 4 dichotomous measures for region of country were included as covariates: West (reference group), Upper Midwest, South, and Northeast. Differences in access to vaping products were also accounted for, which is strongly associated with vaping among youth,[34] by including a measure for ease of obtaining a vaping device (1=very/fairly easy, 0=other). Additional control variables included dichotomous measures (1=yes, 0=no) for past 30–day cigarette, alcohol, and marijuana (not including vaping) use, as well as binge drinking in the past 2 weeks (≥5 drinks in a row).

Statistical Analysis

Analyses consisted of descriptive statistics, logistic regression, and post-estimation analyses. Separate logistic regressions for nicotine and marijuana were conducted. All covariates were used for both nicotine and marijuana, except 30-day marijuana use was excluded (not including vaping) from the marijuana vaping model because of the extreme association between other forms of marijuana use and marijuana vaping.[2] The reference group in the regression models was the low assets group. Two regression models for each outcome were examined: Model 1 included demographics, regions, and vaping device access, and Model 2 added substance use (current cigarette, alcohol, and marijuana use, and current binge drinking) to show the associations of assets even after adjusting for other current substance use. Post-estimation analyses were conducted to examine predicted probabilities of vaping, adjusting for demographics. Predicted scores across all levels of assets were compared (Bonferroni method was used to account for multiple testing). Interactions between asset levels and demographics (race/ethnicity, sex, and parental education) were tested; no interactions were statistically significant (results not included). Weights were used to account for the complex, stratified survey design of the MTF study. Multiple imputation

was used for missing data. Supplemental analyses: (1) adjusted for cohort year (2017, 2018, or 2019) and (2) examined the prevalence and associations for each of the 9 individual assets (using multivariable logistic regression). All analyses were completed with Stata, version 15 software.

RESULTS

The prevalence of current vaping was 18.7% for nicotine and 8.3% for marijuana (Table 1). Most youth had medium assets (55.0%). Other prevalence levels were 25.9% for low assets, and 19.1% for high assets. Approximately 51.7% of the sample had a parent with a college degree. Most students lived in small cities (e.g., suburbs; 45.8%), followed by urban (34.9%) and rural areas (19.3%). The majority of students had definitive plans to attend a 4-year college (56.8%).

Table 2 presents logistic regression results for nicotine vaping. In Model 1 (without substance use covariates), compared with youth with low assets, the odds of nicotine vaping were lower for students with medium assets (AOR=0.65, 95% CI=0.54, 0.78) and high assets (AOR=0.22, 95% CI=0.16, 0.29). In Model 1, each race/ethnicity had lower odds of vaping compared with non-Hispanic White students, and female students had lower odds relative to male students. Ease of obtaining a vaping device was positively associated with vaping. In Model 2 (with substance use covariates), compared with youth with low assets, the odds of nicotine vaping were lower for students with high assets (AOR=0.49, 95% CI=0.35, 0.69), but the difference between low and medium assets was nonsignificant after adjusting for other substance use. Past 30–day use of cigarettes, alcohol, and marijuana (other than vaping) was associated with higher odds of vaping. Binge drinking was associated with higher odds of vaping. Associations remained nearly identical and statistically significant in analyses that adjusted for cohort year.

In Model 1 for marijuana vaping, compared with youth who reported having low assets, the odds of marijuana vaping were lower for youth with medium assets (AOR=0.54, 95% CI=0.42, 0.69) and high assets (AOR=0.09, 95% CI=0.05, 0.18). Black (compared with non-Hispanic White) and female (compared with male) adolescents had lower odds of vaping. Students in rural areas compared with large urban areas, and in the South compared with West, had lower odds of vaping. Ease of obtaining a vaping device was positively associated with vaping. In Model 2, compared with youth who reported having low assets, the odds of marijuana vaping were lower for youth with medium assets (AOR=0.63, 95% CI=0.48, 0.82) and high assets (AOR=0.16, 95% CI=0.08, 0.31), adjusting for other substance use. Past 30–day use of cigarettes and alcohol were associated with higher odds of vaping. Binge drinking was associated with higher odds of vaping. Associations remained nearly identical and statistically significant in analyses that adjusted for cohort year.

As shown in Figure 1, postestimation results demonstrated that there were marked differences in probabilities of nicotine vaping between students who reported low assets compared with students with high assets: a difference of approximately 15 percentage points (20.1% vs 4.9%, respectively). There was also a marked difference in predicted probabilities

of marijuana vaping between students who reported low assets compared with students with high assets: a difference of 10 approximately percentage points (10.8% vs 1.1%).

As shown in Appendix Table 1, there were marked differences in prevalence of the 9 individual assets, ranging from high prevalence for assets such as positive peer norms (73.1%) and family support (69.9%) to low prevalence of assets such as social competence (39.6%) and commitment to learning (13.3%). In multivariable models (Appendix Table 2), adjusting for covariates and other assets, adolescents who reported having social competence and positive peer norms were less likely to report nicotine vaping (AOR=0.25, 95% CI=0.18, 0.34 vs AOR=0.34, 95% CI=0.28, 0.42) and marijuana vaping (AOR=0.04, 95% CI=0.02, 0.12 vs AOR=0.27, 95% CI=0.21, 0.36), with both assets exhibiting strong associations.

DISCUSSION

Increasing prevalence of nicotine and marijuana vaping among adolescents in the U.S. is a critical public health problem to address because vaping nicotine increases the risk of future combustible use and it exposes youth to harmful toxins,[1,5,6] and marijuana vaping affects development and is associated with e-cigarette or vaping use–associated lung injury.[1] U.S. adolescents who report more developmental assets were less likely to report current nicotine and marijuana vaping, even after adjusting for other substance use. Having high assets is most protective compared with medium levels of assets when other risk behaviors are reported. Assets that align with DAF's social competence category and positive peer norms are particularly important assets for vaping.

The HYD perspective can be used to identify factors in adolescence that protect against nicotine and marijuana vaping. The assets framework provides an established roadmap for generating a single measure of cumulative assets.[16,20] Developmental assets have been linked to other substance use outcomes, such as cigarette smoking and alcohol use,[19] but research has not applied cumulative assets to nicotine and marijuana vaping. As cumulative assets were associated with vaping outcomes, programs should follow evidence-based practice that promotes healthy development by building multiple assets, which creates an environment where youth thrive and avoid substance use.[10-15] Promoting cumulative assets can help adolescents cope with stress, thereby reducing risk for vaping. If practitioners only have capacity to promote a single asset, addressing decision-making skills or peer norms could be fruitful. For example, the measure for "social competency" could be considered refusal self-efficacy, and therefore this form of self-efficacy could be an intervention target. In the case of peer norms, personalized feedback interventions that address (mis)perceptions of peer vaping behaviors (e.g., youth often overestimate their peers' substance use)[35] could alter norms around vaping, which could subsequently reduce adolescent vaping.

CONCLUSIONS

The HYD perspective can be applied to nicotine and marijuana vaping among adolescents. Nicotine and marijuana vaping continue to be public health issues, and researchers and practitioners need to develop an evidence base for effective interventions. Rather than strictly focusing on risk-based targets, the HYD allows for a strengths-based approach

that not only protects adolescents against the harms of vaping but also promotes healthy development more broadly. Although the current results are cross-sectional and therefore the results do not demonstrate causal relationships, the project shows that promoting protective factors is a promising approach to decreasing vaping.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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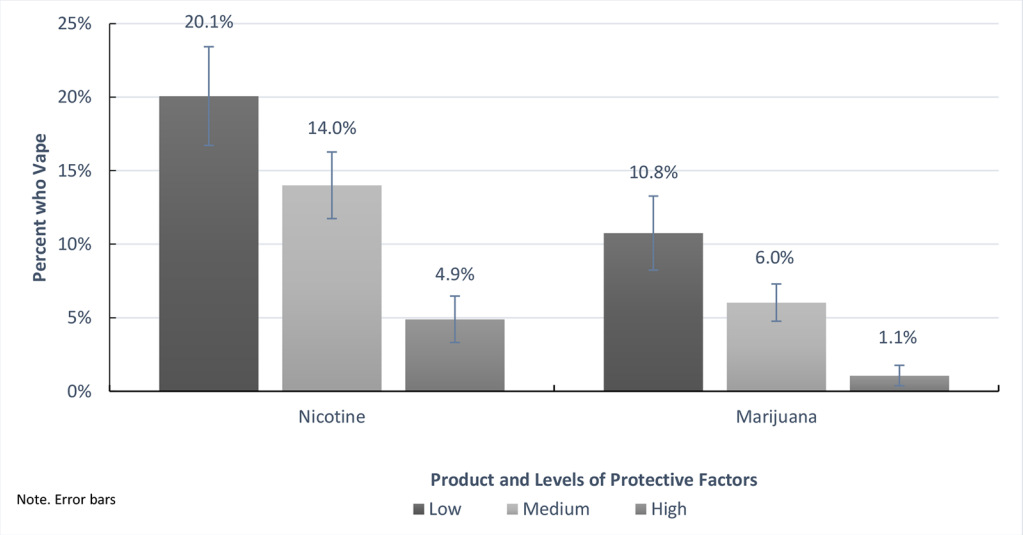

Figure 1.
Predicted probabilities of past 30-day vaping of nicotine or marijuana across levels of assets.

Table 1.

Weighted Descriptive Statistics for Monitoring the Future Sample, 2017–2019

Variables	% or Mean (SE)
Vaping outcomes (past 30 days)	
Nicotine	18.7% (1.02)
Marijuana	8.3% (0.56)
Protective factor levels	
Low (0–3)	25.9% (0.73)
Medium (4–6)	55.0% (0.75)
High (7–9)	19.1% (0.67)
Race/ethnicity	
White	50.5% (2.21)
African American/Black	12.1% (1.08)
Hispanic	21.3% (2.03)
Asian	4.3% (0.52)
Other	11.8% (0.76)
Sex	
Male	47.0% (0.93)
Female	53.0% (0.93)
Parental education	
Some college or less	48.3% (1.49)
College degree or more	51.7% (1.49)
Urban/rural location	
Urban	34.9% (3.47)
Small urban	45.8% (3.35)
Rural	19.3% (1.48)
College plans	
Definitive plans to attend 4 year college	43.2% (1.08)
Other	56.8% (1.08)
Region of country	
South	40.6% (2.19)
Northeast	16.6% (1.62)
Upper Midwest	22.6% (1.68)
West	20.2% (1.94)
Easy to obtain nicotine vaping device	76.9% (1.03)
Past 30-day substance use	
Cigarettes	8.0% (0.47)
Alcohol	32.2% (0.97)
Marijuana (other than vaping)	22.6% (0.78)
Binge drinking in past 2 weeks	12.0% (0.64)

Notes: Unweighted N=6,982. Weights were used to generate estimates, which account for the complex survey design of the Monitoring the Future study; SEs are in parentheses; multiple imputation was used for missing data.

Table 2.

Weighted Logistic Regression Results for Current Nicotine and Marijuana Vaping Among U.S. 12th Graders (Baseline Years 2017–2019)

	Nicotine vaping		Marijuana vaping	
	Model 1	Model 2	Model 1	Model 2
Variables	AOR (95% CI)		AOR (95% CI)	
Level of assets				
Low (reference group)	–	–	–	–
Medium/high	**0.65** (0.54, 0.78)	0.88 (0.70, 1.11)	**0.54** (0.42, 0.69)	**0.63** (0.48, 0.82)
High	**0.22** (0.16, 0.29)	**0.49** (0.35, 0.69)	**0.09** (0.05, 0.18)	**0.16** (0.08, 0.31)
Race/ethnicity (vs White)				
African American/Black	**0.32** (0.22, 0.48)	**0.32** (0.21, 0.49)	**0.51** (0.30, 0.86)	0.78 (0.45, 1.37)
Hispanic	**0.40** (0.28, 0.55)	**0.41** (0.29, 0.58)	0.96 (0.64, 1.43)	1.29 (0.83, 2.01)
Asian	**0.44** (0.24, 0.81)	0.57 (0.30, 1.11)	0.70 (0.36, 1.34)	1.08 (0.57, 2.05)
Other	**0.71** (0.54, 0.93)	0.74 (0.54, 1.02)	1.41 (0.98, 2.04)	**1.80** (1.19, 2.70)
Female (vs male)	**0.64** (0.53, 0.78)	**0.70** (0.56, 0.88)	**0.57** (0.45, 0.73)	**0.63** (0.48, 0.82)
Parental education (vs some college or less)				
College degree or more	1.19 (1.00, 1.43)	1.16 (0.94, 1.43)	1.11 (0.84, 1.45)	1.04 (0.79, 1.37)
Urbanicity (vs urban)				
Small city	1.12 (0.85, 1.47)	1.33 (0.97, 1.83)	0.83 (0.58, 1.18)	0.91 (0.63, 1.32)
Rural	1.07 (0.78, 1.47)	1.15 (0.79, 1.68)	**0.44** (0.28, 0.70)	**0.40** (0.24, 0.65)
Definitive plans to attend 4 year college (vs other)	1.04 (0.86, 1.25)	1.07 (0.87, 1.32)	0.98 (0.74, 1.30)	0.97 (0.71, 1.33)
Region of country				
South	0.88 (0.62, 1.26)	0.90 (0.60, 1.35)	**0.63** (0.40, 0.99)	**0.55** (0.34, 0.89)
Northeast	0.79 (0.54, 1.18)	0.73 (0.46, 1.15)	1.15 (0.71, 1.86)	1.19 (0.73, 1.93)
Upper Midwest	0.88 (0.61, 1.27)	0.91 (0.59, 1.39)	0.83 (0.51, 1.34)	0.80 (0.48, 1.33)
West (reference)				
Easy to obtain nicotine vaping device	**4.63** (3.19, 6.71)	**3.68** (2.43, 5.57)	**2.98** (1.90, 4.67)	**2.25** (1.37, 3.71)
Past 30-day substance use				
Cigarettes	–	**1.63** (1.18, 2.26)		**1.89** (1.35, 2.64)
Alcohol	–	**3.01** (2.37, 3.83)		**3.92** (2.91, 5.29)
Marijuana (other than vaping)	–	**3.78** (3.01, 4.75)		–
Binge drinking in past 2 weeks	–	**1.65** (1.25, 2.17)		**1.81** (1.32, 2.50)

Notes: Unweighted N=6,982. Bolded ORs indicate statistical significance ($p<0.05$). Multiple imputation was used for missing data. Model 1 includes protective factors and demographics, Model 2 includes protective factors, demographics, and current substance use.