Original Investigation | **Public Health**

Prevalence of Electronic Cigarette Use Among Adolescents in New Jersey and Association With Social Factors

Mary Hrywna, PhD, MPH; Michelle T. Bover Manderski, PhD, MPH; Cristine D. Delnevo, PhD, MPH

Abstract

IMPORTANCE Use of electronic cigarettes (e-cigarettes) is high among adolescents, but the extent to which the JUUL e-cigarette brand accounts for the high prevalence has not been explored using population-based surveys.

OBJECTIVE To examine e-cigarette and JUUL use among adolescents in New Jersey.

DESIGN, SETTING, AND PARTICIPANTS Survey study using data from the 2018 New Jersey Youth Tobacco Survey, a cross-sectional statewide representative survey of tobacco use. The survey was school based and sampled New Jersey students in grades 9 to 12.

EXPOSURES Use of tobacco products; JUUL as first tobacco product tried; exposure to JUUL at school; number of friends perceived as JUUL users; liking or following a tobacco brand on social media; and buying or receiving tobacco-branded merchandise.

MAIN OUTCOMES AND MEASURES Prevalence ratio (PR) for current and frequent e-cigarette use, inclusive of JUUL.

RESULTS In this sample of 4183 adolescents, respondents were 49.6% female and 49.6% non-Hispanic white. Students were evenly distributed across grades 9 through 12. Overall, the estimate for current use of e-cigarettes inclusive of JUUL was higher (24.2%; 95% CI, 22.5%-25.9%) compared with current use assessed by use of e-cigarettes only (17.8%; 95% CI, 16.4%-19.4%) or JUUL use only (21.3%; 95% CI, 19.7%-23.0%). Divergence in e-cigarette use estimates was higher for certain subgroups, including female respondents and non-Hispanic black respondents. Also, 88.8% (95% CI, 86.6%-91.1%) of current e-cigarette users reported JUUL as a brand they used. Hispanic students (PR, 0.78; 95% CI, 0.69-0.89) and non-Hispanic students of other races (PR, 0.64; 95% CI, 0.51-0.81) were significantly less likely than non-Hispanic white students to be current e-cigarette users, and students in 12th grade were more likely than those in 9th grade to be current users (PR, 1.29; 95% CI, 1.11-1.48). Current e-cigarette use was positively associated with current use of other tobacco products (PR, 2.57; 95% CI, 2.24-2.95), endorsing a tobacco brand on social media (PR, 1.43; 95% CI, 1.19-1.72), having tobacco-branded merchandise (PR, 1.70; 95% CI, 1.46-1.97), having close friends who used JUUL (PR, 3.81; 95% CI, 3.17-4.58), and seeing JUUL used on school grounds (PR, 1.43; 95% CI, 1.24-1.65). Estimates of prevalence were greater when modeling frequent use.

CONCLUSIONS AND RELEVANCE This study found that prevalence of current and frequent e-cigarette use among adolescents was higher when inclusive of JUUL use, and JUUL was by far the most common e-cigarette brand used, providing support for inclusion of brand-specific questions when assessing e-cigarette use. The results also identify characteristics of adolescents who may be more likely to use e-cigarettes.

Key Points

Question What factors are associated with use of electronic cigarettes (e-cigarettes), including JUUL, among high school students?

Findings In this survey study of 4183 respondents, inclusion of a JUUL use measure produced higher estimates of current use than assessing the use of e-cigarettes or JUUL alone, and 88.8% of youth reported using the JUUL brand. In addition, current use of other tobacco products, endorsing a tobacco brand on social media, having tobacco-branded merchandise, having close friends who used JUUL, and seeing JUUL used on school grounds were significantly associated with current and frequent e-cigarette use, inclusive of JUUL.

Meaning These findings suggest that adolescents who report current JUUL use may not report current e-cigarette use, and future measures of e-cigarette use should include specific questions or examples of the most popular brands.

+ Author affiliations and article information are listed at the end of this article.

Introduction

Electronic cigarettes (e-cigarettes) have been the most commonly used tobacco product among adolescents since 2014.[1] The 2018 National Youth Tobacco Survey revealed that e-cigarette use increased considerably among high school students between 2017 and 2018.[1] Among high school students, current e-cigarette use increased from 11.7% in 2017 to 20.8% in 2018,[2] and frequent use (≥20 of past 30 days) more than doubled from 2017 (2.5%) to 2018 (5.9%).[1] Although the JUUL brand was recognized as likely contributing to the rapid growth in e-cigarette use, the 2018 National Youth Tobacco Survey did not ask about use of JUUL specifically.[2]

The rapid growth in e-cigarette use among young people coincides with the meteoric rise of JUUL, a type of pod-based device that now dominates the market. By fall 2018, JUUL had captured more than 70% of the branded e-cigarette market, increasing from approximately 25% market share just 1 year earlier.[3] The appeal of JUUL may be its use of nicotine salts, discreet design making it easy to conceal, and variety of flavors. In response to public concern about youth JUUL use, over the last 2 years, JUUL Labs stopped the sale of flavors (except menthol); suspended its social media accounts as well as broadcast, print, and digital advertising; announced plans to enhance age verification systems; and began advocating for increasing the minimum tobacco purchase age to 21 years.[4,5] Most recently, several states and cities enacted or are considering bans on e-cigarettes or e-cigarette flavors.

The small but growing literature on JUUL use among young people points to JUUL awareness and use increasing over time and with age.[6-11] JUUL awareness and/or use is also higher among youths who are male,[12,13] white,[10,13] and of higher socioeconomic status.[10] A spring 2017 survey at 4 Connecticut high schools found that among ever and current e-cigarette users, 47.1% currently used JUUL compared with 33.1% who used other mod devices and 18.1% who used vape/hookah pens.[10]

Fewer studies on JUUL used probability samples, and of these, measurement was limited.[6,7,9,11] Details regarding patterns of adolescent e-cigarette use were largely restricted to crude measures of current or ever use, which do not capture frequency or first product tried, for example. Moreover, incorporating brand-specific survey items in population-based surveillance is important given that some current JUUL users may not report current e-cigarette use or consider JUUL an e-cigarette.[14,15] In addition, other social and behavioral aspects of JUUL (eg, peer use, exposure at school) are not well understood and, if studied, were based mostly on smaller nonprobability samples of young adults.[12-15] This study builds on the nascent literature and examines current and frequent e-cigarette and JUUL use and factors associated with use among a large probability sample of New Jersey public high school students. We also consider the extent to which adolescents report JUUL as the first tobacco product tried, exposure to JUUL use in school, and peer influences (ie, whether close friends use JUUL).

Methods

Data Source

The New Jersey Youth Tobacco Survey (NJYTS) is a survey of public high school students in New Jersey and collects detailed data on tobacco use. The NJYTS, conducted biennially since 1999, has a long history of innovating and advancing tobacco use measurement among youth,[16-18] often ahead of national and state efforts. Specific questions about the JUUL brand of e-cigarettes were introduced in the 2018 NJYTS, an in-class paper survey administered to students between October and December 2018. The Health Sciences institutional review board at Rutgers University approved the survey with a waiver of written consent contingent on school preference. In schools that chose survey administration under the waiver, parents returned a form to the school if they declined participation, whereas in schools that chose written consent procedures, parents returned a form indicating consent for the child to participate. Prior to administration, survey staff informed students that participation was voluntary and anonymous, and survey completion was an indication of assent.

The 2018 NJYTS used a 2-stage cluster sample design to select a representative sample of public high school students in New Jersey. First, 50 schools (containing any of grades 9-12) were sampled with probability proportional to enrollment size for recruitment, and 38 schools (76%) agreed to participate. Second, approximately 3 to 4 classes were sampled via systematic equal probability sampling within each participating school, yielding a total of 4820 eligible students, of whom 86.8% completed the survey. The overall response rate, calculated by multiplying the school response rate by the student response rate, was 66.0%.

Measures

Participants were asked about current use (use on ≥1 of the past 30 days) and frequent use (use on ≥20 of the past 30 days) of cigarettes, cigars, smokeless tobacco, snus, and hookah, as well as e-cigarettes in general and JUUL specifically. Prior to questions about e-cigarette use, the survey introduced e-cigarettes as "battery powered devices that usually contain a nicotine-based liquid that is vaporized and inhaled. You may know them as pod-mods, vape-pens, hookah-pens, e-hookahs, e-cigars, e-pipes, personal vaporizers, or mods." Electronic cigarette use was assessed by the question, "During the past 30 days, on how many days did you use an e-cigarette?" and JUUL use was specifically assessed by the question, "During the past 30 days, on how many days did you use JUUL?" Because JUUL users may not identify as e-cigarette users, we calculated enhanced current and frequent e-cigarette measures that were inclusive of JUUL use, such that an affirmative response to either the general e-cigarette question or the JUUL-specific question indicated use of e-cigarettes and/or JUUL.

Exposure to tobacco brands on social media was defined as responding affirmatively to the question, "In the past 12 months, have you visited, followed, liked, or become a fan of a tobacco brand on sites like Instagram, Twitter, Facebook, or YouTube?" Exposure to tobacco-branded merchandise was defined as responding affirmatively to the question, "During the past 12 months, did you buy or receive anything that has a tobacco company name or picture on it?" Peer use was assessed by asking how many of the student's 4 closest friends used JUUL; answering 1 or more friends was coded as positive for peer use. Seeing JUUL on school grounds was assessed by asking whether students had seen youths or adults smoking or using JUUL on school grounds in the past 30 days. Response options included "Yes indoors," "Yes outdoors," "Yes indoors and outdoors," and "No."

We also describe past month e-cigarette brand use, assessed by a question that asked students to check all that applied: "During the past 30 days, what brand(s) of e-cigarettes did you use?" (answers included Blu, Bo, Green Smoke, JUUL, Logic, MarkTen, Myle, NJOY, Suorin, Vuse, Zoor, and some other brand). We assessed how many respondents reported JUUL as the first product tried ("Which of the following products did you try FIRST?"). Demographic characteristics included sex, race/ethnicity, and school grade level.

Statistical Analysis

Estimates were weighted to adjust for probabilities of selection and nonresponse using SAS software version 9.4 (SAS Institute) and SUDAAN software version 11.0.3 (RTI International), which account for the complex sampling design; thus, estimates are representative of public high school students in New Jersey. Point (prevalence) estimates and 95% confidence intervals were calculated overall and by subgroup for current and frequent JUUL use (based on the JUUL-specific question), e-cigarette use (based on the general e-cigarette question), and current e-cigarette or JUUL use (derived from both general and JUUL-specific questions). To adjust for the design effect, differences across subgroups were tested using Rao-Scott χ^2 tests, with 2-tailed P values less than .05 indicating statistical significance. Demographic and tobacco use characteristics associated with JUUL and e-cigarette use were identified using multivariable logistic regression. Because odds ratios can overestimate associations with common outcomes, adjusted prevalence ratios (PRs) were calculated from average marginal predictions.[19-21]

Results

The final sample included 4183 New Jersey public high school students. As shown in **Table 1**, 49.6% were female and 49.6% were non-Hispanic white; students were evenly distributed across grades. More than 1 of 3 high school youths in New Jersey reported ever trying an e-cigarette, inclusive of JUUL (37.6%; 95% CI, 35.6%-39.6%). **Table 2** details the prevalence of current and frequent e-cigarette use, current and frequent JUUL use, and current and frequent e-cigarette use inclusive of JUUL use. Estimates of e-cigarette use were significantly higher when the e-cigarette operational definition included JUUL, resulting in overall increases in current use by 6.4 percentage points and frequent use by 1.4 percentage points. The magnitude of the increase varied by demographic subgroups. For example, among female respondents, it resulted in a 7.9–percentage point increase in current use prevalence. For non-Hispanic black students, current use prevalence nearly doubled (9.6%; 95% CI, 7.0%-13.0% to 18.7%; 95% CI, 15.4%-22.7%) when including JUUL use. Given such underestimation, we used the operational definition of e-cigarettes inclusive of JUUL use to report current and frequent use of e-cigarettes in the following results.

Overall, the estimate for current use of e-cigarettes inclusive of JUUL was 24.2% (95% CI, 22.5%-25.9%) among high school youth in New Jersey compared with current use assessed by use of e-cigarettes only (17.8%; 95% CI, 16.4%-19.4%) or JUUL use only (21.3%; 95% CI, 19.7%-23.0%). There were no differences by sex. Current use increased with school grade, with 32.6% (95% CI, 29.4%-36.0%) of 12th-grade students reporting current use. White high school students had significantly higher rates of current use (29.1%; 95% CI, 26.4%-32.0%) than all other racial/ethnic groups. Frequent use was reported by 6.5% (95% CI, 5.7%-7.5%) of high school students. Slightly higher prevalence was noted for male students (7.5%; 95% CI, 6.2%-8.9%) compared with female students (5.6%; 95% CI, 4.6%-6.8%) (P = .02). Frequent use increased with school grade, and 10.3% (95% CI, 8.4%-12.6%) of 12th-grade students used e-cigarettes on most days. Prevalence of frequent use was significantly higher for non-Hispanic white respondents (8.7%; 95% CI, 7.3%-10.3%) than for other racial/ethnic groups.

Table 3 presents overall patterns of tobacco use and exposure among all high school students as well as past 30-day e-cigarette brand use among e-cigarette users. Overall, current use of cigarettes (2.9%; 95% CI, 2.4%-3.6%) or any traditional tobacco products (10.1%; 95% CI, 9.0%-11.3%) was low. Few students liked or followed a tobacco brand on social media (8.6%; 95% CI, 7.7%-9.5%) or bought or received tobacco-branded merchandise in the past 12 months (8.3%; 95% CI, 7.3%-9.4%). A total of 16.6% (95% CI, 15.1%-18.3%) of students indicated JUUL as the first product tried. Peer use of JUUL was common (41.0%; 95% CI, 39.0%-43.0%). More than half of high

Table 1. Demographic Characteristics of 4183 High School Students, 2018 New Jersey Youth Tobacco Survey

Characteristic	Unweighted No.[a]	Weighted % (95% CI)
Sex		
Male	2048	50.4 (48.5-52.3)
Female	2116	49.6 (47.7-51.5)
Grade		
9th	1155	25.6 (20.2-31.9)
10th	741	25.0 (18.7-32.6)
11th	844	24.8 (18.9-31.9)
12th	1407	24.6 (19.9-30.0)
Race/ethnicity		
Non-Hispanic		
White	1636	49.6 (47.4-51.8)
Black	519	14.3 (13.0-15.8)
Hispanic	1353	25.0 (23.3-26.7)
Non-Hispanic other race	619	11.2 (9.9-12.6)

[a] May not total to sample total owing to item nonresponse.

school students in New Jersey reported seeing JUUL used on school grounds (56.8%; 95% CI, 54.6%-58.9%).

Of current e-cigarette users, 88.8% (95% CI, 86.6%-91.1%) reported using the JUUL brand in the 30 days preceding the survey. Other e-cigarette brands reported by current users included Suorin, Blu, and Myle, but use of these brands was less common (Table 3). Likewise, 95.0% (95% CI, 92.4%-97.6%) of frequent e-cigarette users reported use of JUUL and 25.5% (95% CI, 19.0%-32.1%) reported using Suorin. While use of more than 1 e-cigarette brand was common, 55.7% (95% CI, 52.1%-59.4%) of current users and 46.7% (95% CI, 39.8%-53.7%) of frequent users reported exclusive use of the JUUL brand in the past month.

As shown in **Table 4**, prevalence of current and frequent e-cigarette use was high among students who also reported currently using 1 or more traditional tobacco product (73.5%; 95% CI, 67.9%-78.4% and 30.1%; 95% CI, 25.4%-35.1%, respectively). Those who liked or followed a tobacco brand on social media also had high rates of current (53.3%; 95% CI, 46.7%-59.7%) and frequent (21.1%; 95% CI, 16.4%-26.7%) e-cigarette use. Similarly, among students who bought or received tobacco-branded merchandise in the past 12 months, 63.3% (95% CI, 56.5%-69.6%) were current users of e-cigarettes and 30.5% (95% CI, 25.0%-36.5%) were frequent users. Among students who

Table 2. Prevalence of Current and Frequent e-Cigarette or JUUL Use in 4183 Respondents to the 2018 New Jersey Youth Tobacco Survey

Characteristic	% (95% CI)		
	JUUL Use	e-Cigarette Use	e-Cigarette and/or JUUL Use
Current Use (Any in Past 30 d)			
Overall	21.3 (19.7-23.0)	17.8 (16.4-19.4)	24.2 (22.5-25.9)
Sex			
Male	20.4 (18.1-23.0)	18.5 (16.3-20.9)	23.4 (21.0-26.0)
Female	22.1 (19.7-24.7)	17.0 (15.0-19.2)	24.9 (22.5-27.4)
Grade			
9th	14.1 (11.8-16.8)	10.5 (8.5-12.9)	16.8 (14.3-19.7)
10th	20.0 (16.0-24.6)	17.4 (14.0-21.3)	23.4 (19.4-28.0)
11th	21.1 (17.5-25.1)	18.5 (15.6-21.9)	23.7 (20.1-27.6)
12th	30.0 (27.0-33.3)	24.7 (21.8-27.8)	32.6 (29.4-36.0)
Race/ethnicity			
Non-Hispanic			
White	26.7 (24.1-29.5)	22.3 (20.0-24.8)	29.1 (26.4-32.0)
Black	16.7 (13.3-20.7)	9.6 (7.0-13.0)	18.7 (15.4-22.7)
Hispanic	18.1 (15.8-20.8)	16.7 (14.3-19.5)	22.8 (20.2-25.5)
Non-Hispanic other race	10.7 (7.8-14.5)	10.7 (7.8-14.6)	12.4 (9.3-16.3)
Frequent Use (>20 in Past 30 d)			
Overall	5.1 (4.4-6.0)	5.1 (4.3-5.9)	6.5 (5.7-7.5)
Sex			
Male	5.7 (4.6-6.9)	5.9 (4.8-7.2)	7.5 (6.2-8.9)
Female	4.6 (3.7-5.7)	4.3 (3.4-5.4)	5.6 (4.6-6.8)
Grade			
9th	2.9 (1.9-4.4)	2.0 (1.3-3.2)	3.1 (2.1-4.6)
10th	4.0 (2.5-6.4)	3.7 (2.4-5.5)	4.8 (3.1-7.2)
11th	4.8 (3.5-6.6)	5.9 (4.4-7.9)	7.6 (5.8-9.7)
12th	8.5 (6.8-10.5)	8.7 (6.8-11.0)	10.3 (8.4-12.6)
Race/ethnicity			
Non-Hispanic			
White	6.8 (5.7-8.1)	7.4 (6.1-8.9)	8.7 (7.3-10.3)
Black	3.6 (2.1-6.1)	1.8 (0.9-3.5)	3.7 (2.2-6.2)
Hispanic	3.8 (2.8-5.1)	3.0 (2.2-4.2)	4.9 (3.8-6.4)
Non-Hispanic other race	2.6 (1.2-5.3)	3.5 (1.9-6.2)	3.5 (2.0-6.2)

Abbreviation: e-cigarette, electronic cigarette.

indicated JUUL as the first product tried, 65.9% (95% CI, 61.0%-70.5%) were currently using e-cigarettes and 15.3% (95% CI, 12.4%-18.7%) were frequent users. Overall, among current e-cigarette users, 45.9% (95% CI, 42.2%-49.6%) reported that JUUL was the first tobacco product they tried. Current and frequent e-cigarette use were more prevalent among students who had friends using JUUL compared with those who did not. Among those who observed JUUL use on school grounds, prevalence of current or frequent e-cigarette use was higher.

In multivariable analysis (**Table 5**), Hispanic students (PR, 0.78; 95% CI, 0.69-0.89) and non-Hispanic students of other races (PR, 0.64; 95% CI, 0.51-0.81) were significantly less likely than non-Hispanic white students to be current e-cigarette users, and 12th-grade students were 29% more likely than 9th-grade students to be current users (PR, 1.29; 95% CI, 1.11-1.48). Sex was not

Table 3. Tobacco Use Patterns Among 4183 High School Students and Brand Use Among Current and Frequent Users of JUUL or e-Cigarettes, 2018 New Jersey Youth Tobacco Survey

Pattern or Brand	% (95% CI)
All students (n = 4183)	
Tobacco use patterns	
Past-30-d use of cigarettes	2.9 (2.4-3.6)
Past-30-d use of any traditional tobacco product[a]	10.1 (9.0-11.3)
Like or follow a tobacco brand on social media, past 12 mo	8.6 (7.7-9.5)
Buy or receive tobacco-branded merchandise, past 12 mo	8.3 (7.3-9.4)
First product was JUUL	16.6 (15.1-18.3)
Friend(s) use JUUL	41.0 (39.0-43.0)
Seen JUUL on school grounds	56.8 (54.6-58.9)
Current e-cigarette users (n = 799)	
e-Cigarette brands used in past 30 d	
JUUL	88.8 (86.6-91.1)
Suorin	10.5 (8.2-12.8)
Blu	8.7 (6.8-10.7)
Myle	7.5 (5.5-9.6)
Bo	3.2 (2.0-4.5)
Vuse	2.0 (0.9-3.1)
Logic	2.5 (1.4-3.6)
NJOY	1.3 (0.1-2.6)
Zoor	1.6 (0.7-2.5)
MarkTen	1.6 (0.7-2.4)
Green Smoke	1.7 (0.8-2.7)
Frequent e-cigarette users (n = 262)	
e-Cigarette brands used in past 30 d	
JUUL	95.0 (92.4-97.6)
Suorin	25.5 (19.0-32.1)
Blu	10.5 (6.4-14.5)
Myle	16.3 (10.8-21.8)
Bo	4.9 (2.2-7.6)
Vuse	4.0 (0.8-7.3)
Logic	3.7 (1.2-6.1)
NJOY	1.9 (0.0-3.9)
Zoor	3.4 (0.9-5.9)
MarkTen	2.8 (0.5-5.1)
Green Smoke	3.7 (0.8-6.5)

Abbreviation: e-cigarette, electronic cigarette.

[a] Cigarettes, cigars, smokeless (including snus), or hookah.

associated with current use. Current e-cigarette use was positively associated with current use of other (traditional) tobacco products (PR, 2.57; 95% CI, 2.24-2.95), liking or following a tobacco brand on social media (PR, 1.43; 95% CI, 1.19-1.72), buying or receiving tobacco-branded merchandise (PR, 1.70; 95% CI, 1.46-1.97), having 1 or more close friends who use JUUL (PR, 3.81; 95% CI, 3.17-4.58), and seeing JUUL used on school grounds (PR, 1.43; 95% CI, 1.24-1.65). Frequent use was similarly associated with grade, race/ethnicity, current tobacco product use, endorsing a tobacco brand on social media, having tobacco-branded merchandise, having close friends who use JUUL, and seeing JUUL used on school grounds; estimates of prevalence were greater when modeling frequent use.

Discussion

This study used a population-based survey of adolescents that included specific questions on JUUL to provide more definitive data that adolescents are overwhelmingly using this popular brand of e-cigarettes. One of 4 adolescents reported current use of e-cigarettes in 2018, which reflects a significant increase from the 2016 NJYTS when 1 of 10 adolescents reported current e-cigarette use.[22] During this time, current cigarette use among New Jersey youth also decreased to the lowest rate recorded in the NJYTS (2.9%); this reflects a 38% decline from 2016 (4.7%).[22] While there were national efforts to discourage tobacco use before and during this time, there were no state-level tobacco control funding in New Jersey between 2010 and 2018 or state-level tobacco tax increases.

Consistent with previous work,[13,23] we found a notable proportion of adolescents who reported using JUUL but did not answer affirmatively to questions about e-cigarette use, which suggests that asking about e-cigarettes alone will underestimate prevalence. In addition, the degree to which

Table 4. Prevalence of Current and Frequent e-Cigarette or JUUL Use by Associated Factors, 2018 New Jersey Youth Tobacco Survey

Factor	e-Cigarette or JUUL Use, % (95% CI)	
	Current (n = 977)	Frequent (n = 262)
Tobacco use patterns		
Past-30-d use of cigarettes		
Yes	86.7 (78.5-92.1)	35.9 (28.5-44.0)
No	22.2 (20.7-23.9)	5.6 (4.8-6.5)
Past-30-d use of any traditional tobacco product[a]		
Yes	73.5 (67.9-78.4)	30.1 (25.4-35.1)
No	18.7 (17.2-20.2)	3.9 (3.2-4.8)
Tobacco brand marketing exposure		
Like or follow a tobacco brand on social media, past 12 mo		
Yes	53.3 (46.7-59.7)	21.1 (16.4-26.7)
No	21.3 (19.8-23.0)	5.1 (4.3-6.0)
Buy or receive tobacco-branded merchandise, past 12 mo		
Yes	63.3 (56.6-69.6)	30.5 (25.0-36.5)
No	20.5 (19.0-22.0)	4.3 (3.6-5.1)
JUUL experiences		
First product was JUUL		
Yes	65.9 (61.0-70.5)	15.3 (12.4-18.7)
No	15.5 (14.0-17.2)	4.7 (3.9-5.7)
Friend(s) use JUUL		
Yes	46.3 (43.8-48.9)	13.7 (12.0-15.6)
No	7.1 (5.8-8.7)	1.2 (0.8-1.9)
Not sure	19.5 (15.2-24.7)	3.3 (1.8-5.9)
Seen JUUL on school grounds		
Yes	34.2 (32.0-36.6)	9.6 (8.3-11.1)
No	11.0 (9.3-13.1)	2.1 (1.5-3.1)

Abbreviation: e-cigarette, electronic cigarette.

[a] Cigarettes, cigars, smokeless (including snus), or hookah.

e-cigarette prevalence was underestimated varies for demographic subgroups (ie, female students and black students); our results were consistent with previous research using a smaller school-based sample, which found that discordance between reporting e-cigarette use and use of specific e-cigarette devices was higher among JUUL users, female individuals, and nonwhite individuals.[24] Historically, e-cigarette use has been lower for black youth and adults,[25,26] but our results suggest that the JUUL brand of e-cigarettes may be expanding its market reach. Indeed, the prevalence of current e-cigarette use doubled for black New Jersey high school students when the JUUL-specific question was included in the measure of current e-cigarette use.

Frequent e-cigarette use, or use on 20 or more days in the preceding 30 days, was not inconsequential and was highest among 12th-grade students in New Jersey (10.3% in 2018). Our findings are similar to national estimates from Monitoring the Future,[27] which found that 11.7% of high school seniors use e-cigarettes daily. These patterns of youth use are concerning and likely strong indicators of addiction and dependence,[28] which would be consistent with the nicotine delivery of these products.[29] In addition, polytobacco use was common and e-cigarette prevalence was much higher among adolescents also reporting use of other tobacco products.

Our findings suggest that youth e-cigarette use is largely associated with JUUL and, to a lesser degree, other high-nicotine content pod-based e-cigarettes that emerged on the market after JUUL,

Table 5. Multivariable Associations With Current and Frequent Use of JUUL or e-Cigarettes Among 4183 High School Students, 2018 New Jersey Youth Tobacco Survey

Factor	Adjusted Prevalence Ratio of e-Cigarette or JUUL Use (95% CI)[a]	
	Current	Frequent
Sex		
Male	1 [Reference]	1 [Reference]
Female	1.06 (0.94-1.19)	0.85 (0.67-1.09)
Grade		
9th	1 [Reference]	1 [Reference]
10th	1.19 (1.00-1.42)	1.29 (0.80-2.04)
11th	1.09 (0.93-1.27)	1.74 (1.11-2.72)
12th	1.29 (1.11-1.48)	1.92 (1.23-3.01)
Race/ethnicity		
Non-Hispanic		
White	1 [Reference]	1 [Reference]
Black	0.97 (0.81-1.16)	0.61 (0.36-1.05)
Hispanic	0.78 (0.69-0.89)	0.47 (0.34-0.64)
Non-Hispanic other race	0.64 (0.51-0.81)	0.56 (0.33-0.96)
Past-30-d use of any traditional tobacco product[b]		
Yes	2.57 (2.24-2.95)	3.40 (2.49- 4.64)
No	1 [Reference]	1 [Reference]
Like or follow a tobacco brand on social media, past 12 mo		
Yes	1.43 (1.19-1.72)	1.61 (1.13-2.28)
No	1 [Reference]	1 [Reference]
Buy or receive tobacco-branded merchandise, past 12 mo		
Yes	1.70 (1.46-1.97)	2.92 (2.15-3.98)
No	1 [Reference]	1 [Reference]
Friend(s) use JUUL		
Yes	3.81 (3.17-4.58)	5.09 (2.96-8.76)
Not sure	2.15 (1.70-2.73)	2.17 (1.04-4.53)
No	1 [Reference]	1 [Reference]
Seen JUUL on school grounds		
Yes	1.43 (1.24-1.65)	1.53 (1.06-2.21)
No	1 [Reference]	1 [Reference]

Abbreviation: e-cigarette, electronic cigarette.

[a] Adjusted prevalence ratio computed using average marginal predictions.

[b] Cigarettes, cigars, smokeless (including snus), or hookah.

such as Suorin and Myle. Indeed, nearly 90% of current high school e-cigarette and/or JUUL users reported JUUL as a brand used in the past 30 days. Brand preferences among New Jersey adolescents are in line with the 2019 National Youth Tobacco Survey results, which also showed that JUUL was by far the usual brand reported among adolescent e-cigarette users nationally.[30] In addition, almost half of adolescent e-cigarette users reported initiating tobacco or nicotine product use with JUUL.

Environmental factors, including peers, school, and tobacco marketing, can influence tobacco use behavior among adolescents. Having close friends who use JUUL was associated with current and frequent e-cigarette use, particularly use of JUUL, among high school students. In addition, there was an association between current and frequent e-cigarette use and seeing JUUL used at school. While more than 80% of schools in a recent study had a general e-cigarette policy in place and more than 40% of policies specifically included JUUL, the discreet appearance and difficulty in locating the vapor source were often cited as barriers to enforcement.[31] The prevalence of current and frequent e-cigarette use among adolescents was also associated with exposure to tobacco-branded social media and/or merchandise, even after adjusting for use of other tobacco products. Before voluntarily shutting down its social media sites in November 2018, JUUL was one of the first major retail e-cigarette brands to rely heavily on social media marketing and promotion, including Twitter, Instagram, and YouTube.[32]

Limitations

Our results should be interpreted in the context of several limitations. First, data were collected in New Jersey and, therefore, are not nationally representative, although these data mirror national trends among US high school students and provide population-based analyses of specific JUUL measures. As such, the study findings have implications for tobacco control policy and programs nationally. Second, these data were self-reported and might be subject to response bias. Third, findings might not be generalizable to all high school students, such as those who are enrolled in private or alternative schools or are home-schooled.

Conclusions

Overall, this study suggests that youth who report current e-cigarette use are overwhelmingly using the JUUL brand of e-cigarettes. Given the introduction and growth of high-nicotine pod-based e-cigarettes, the changing tobacco product landscape, and its potential impact on public health, continued surveillance of trends in use of JUUL and other specific brands is warranted. Specifically, this study provides evidence to support inclusion of brand-specific measures in national and state surveys of tobacco use to more accurately assess adolescent e-cigarette use. In addition, policies to limit or restrict e-cigarette branded social media and merchandise should be considered given the potential to influence youth. Furthermore, identifying population groups most likely to be frequent and current e-cigarette users may allow clinicians to appropriately target adolescent patients for intervention.

Corresponding Author: Mary Hrywna, PhD, MPH, Rutgers Center for Tobacco Studies, 303 George St, Room 524, New Brunswick, NJ 08901 (mary.hrywna@rutgers.edu).

Author Affiliations: Department of Health Behavior, Society and Policy, Rutgers School of Public Health,

Piscataway, New Jersey (Hrywna, Delnevo); Department of Biostatistics and Epidemiology, Rutgers School of Public Health, Piscataway, New Jersey (Bover Manderski); Rutgers Center for Tobacco Studies, New Brunswick, New Jersey (Hrywna, Bover Manderski, Delnevo); Rutgers Cancer Institute of New Jersey, New Brunswick (Hrywna, Bover Manderski, Delnevo).

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