

Use and Perceived Risk of Electronic Cigarettes Among North Carolina Middle and High School Students

Coral X. Giovacchini, Lauren Pacek, F. Joseph McClernon, Loretta G. Que

PURPOSE Electronic cigarette (e-cigarette) use continues to rise among adolescents, but little is known regarding their risk perceptions of e-cigarette use. We aimed to describe the lifetime use and perceived risk of e-cigarette use in the context of other risk-taking behaviors among adolescents in North Carolina.

METHODS Data were derived from the 2015 North Carolina Youth Risk Behavior Survey, which was administered to 503 middle school and 444 high school students in the Chapel Hill-Carrboro public school district. Survey participants self-reported their sex; ethnicity; school grade; ever-use of cigarettes, e-cigarettes, alcohol, and other illicit substances; perceived risk of harm of these products; and perceived view of their parents' and friends' perceptions of these products. Logistic regression analyses were used to assess associations between student-reported characteristics, risk behaviors, perceived product risk, and ever-use of e-cigarettes.

RESULTS This study found that 4.6% of middle school students and 37.2% of high school students reported ever-use of e-cigarettes. E-cigarette use increased and perception of e-cigarette risk decreased with advancing grade. Ever-use of e-cigarettes surpassed ever-use of combustible cigarettes at all grades; 49.4% of e-cigarette users had never smoked cigarettes. The perception that friends view e-cigarette use as "wrong" correlated negatively with e-cigarette use (adjusted odds ratio = 0.43; 95% confidence interval, 0.19–0.97).

LIMITATIONS Self-reported results from students in one school district have limited generalizability to larger groups.

CONCLUSION E-cigarette use among adolescents in North Carolina correlates positively with perceived friends' views of e-cigarettes, and use correlates negatively with personal perception of the risk of e-cigarettes. Based on our survey results, education and public health intervention regarding e-cigarette use may be best targeted at youth prior to their transition to high school.

Electronic cigarettes (e-cigarettes) are a class of products that deliver an aerosolized liquid—usually containing a blend of propylene glycol and/or glycerin, a variety of flavors, and, typically, nicotine—to simulate the experience of cigarette smoking [1, 2]. Since the introduction of e-cigarettes to the US market in 2007, these products have rapidly evolved to encompass a spectrum of devices ranging from the original "ciga-like" prototype to large tank-style and fully customizable electronic nicotine delivery systems [1, 3]. Accordingly, public awareness and use of e-cigarettes has risen among both adult and adolescent populations [1]. Data from the National Tobacco Survey, which is administered by the Centers for Disease Control and Prevention (CDC), indicated that overall public awareness of e-cigarettes nearly doubled between 2010 and 2013 (40.9% to 79.7%), with increases in both awareness and use observed across nearly all groups, independent of sex, age, ethnicity, religion, education level, income, or current use of combustible tobacco [3].

Moreover, studies have revealed that e-cigarette use has risen dramatically among adolescents. The most recent National Youth Tobacco Survey (NYTS) reported that 13.4% of high school students self-reported using e-cigarettes in 2014, an increase from 1.5% in 2011 [4, 5]. Further, the 2015 Monitoring The Future Survey (MTFS) reported that, among students in the 8th, 10th, and 12th grades, e-cigarettes have

surpassed all other tobacco products in prevalence of use, with 16.3% of 12th-grade students nationally reporting e-cigarette use within the past 30 days [6].

While some evidence suggests that e-cigarettes are publically perceived as a potentially less harmful alternative to combustible tobacco cigarettes [7] or occasionally are used as a smoking cessation aid [8], other evidence suggests that e-cigarettes are associated with adolescents' transition to the use of combustible tobacco cigarettes [9-11]. Findings also suggest that e-cigarette use, particularly during the vulnerable periods of adolescence when individuals are more prone to risk-taking behavior [12], is linked to ongoing cigarette smoking in the transition from adolescence to adulthood [13].

Prior studies have suggested that adolescents view e-cigarettes as posing less health risk than combustible cigarettes [5, 14, 15] and that adolescents whose friends view e-cigarettes favorably may be more likely to use e-cigarettes themselves [5]. Similarly, adolescents who report the use of

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e-cigarettes among other members of their household had higher odds of using e-cigarettes [5]. While previous studies have suggested that the perception by an adolescent's parent of combustible cigarette smoking being normative or socially acceptable is a strong predictor of adolescent cigarette smoking [5, 16], little is known about the influence of parental perception on adolescents' risk for using e-cigarettes.

Our study aimed to answer 4 main questions: What is the prevalence of ever-use of combustible cigarettes and of e-cigarettes among middle school and high school students? What is the perceived risk associated with the use of these products? What is the association between combustible cigarette and e-cigarette use and academic grade level? What are the correlates of current e-cigarette use among adolescents in a single county in North Carolina, a state with relatively high tobacco product use among youth and young adults [17-19]? To our knowledge, the current study is the first to report adolescent risk perceptions of e-cigarette use and adolescents' perceptions of their parents' attitudes toward e-cigarette use.

Methods

Data Source

Data came from the 2015 North Carolina Youth Risk Behavior Survey (NCYRBS). The NCYRBS is a school-based survey designed by the CDC and administered biennially to North Carolina public school students, at the discretion of individual school districts, by the North Carolina Department of Public Instruction and the State Board of Education. The NCYRBS is designed to monitor health risk behaviors that contribute to death, disability, and social problems. The survey is administered to students in 6th-grade through 12th-grade classes that are randomly selected using a self-weighting 2-stage cluster sampling procedure. The survey examines 6 general health risk behaviors that contribute to unintentional injuries or violence, alcohol and other drug use, inadequate physical activity, tobacco use, unhealthy dietary behaviors, and sexual behaviors leading to unintended pregnancy and/or sexually transmitted disease. Data for the present analysis came from the NCYRBS administered to students in Chapel Hill-Carrboro City Schools in Orange County (4 middle schools and 3 high schools), which added questions about e-cigarette use and perceptions to the 2015 survey.

Passive parental consent was obtained prior to administration of the survey. Specifically, participating schools distributed a letter to parents that included the study description and consent form; parents only returned the signed consent form if they refused consent. Less than 1% of parents refused consent, which yielded a survey response rate above 99%. All answers were collected anonymously via self-report. Surveys were administered under supervised "test" conditions. Separate surveys were administered to middle school students (grades 6-8) and high school stu-

dents (grades 9-12); the surveys included 79 and 100 questions, respectively, and they had 74 questions in common. Analyses are based on de-identified data and do not require approval by an institutional review board.

Measures

Sociodemographics. Students reported their sex, race (white, African American, Asian, other), ethnicity (Hispanic, non-Hispanic), and grade (6-12).

Cigarette, e-cigarette, alcohol, and substance use. Students indicated whether they had ever used cigarettes, e-cigarettes, or alcohol during their lifetimes (yes/no). To address current use of e-cigarettes, students were asked on how many of the past 30 days they had used an e-cigarette or electronic vapor product (1-30). Students were also questioned about their nonmedical lifetime use (yes/no) of a number of illicit drugs, including cannabis, cocaine, steroids, and prescription drugs. A dichotomous composite variable was created for "any illicit drug use" that summed across each of the aforementioned substances.

Perceived Risk

Students responded to the following question about their perceived risk of harm from using cigarettes and e-cigarettes: "How much do you think people risk harming themselves (physically or in other ways) if they use [product]?" Response options were "no risk," "slight risk," "moderate risk," and "great risk." For the purposes of the present analyses, dichotomous variables were created to compare the perception of "great risk" to "other perceived risk." Additionally, students were asked, "How wrong do your friends feel it would be for you to use [product]?" and "How wrong do your parents feel it would be for you to use [product]?" for both cigarettes and e-cigarettes. Response options were "not at all wrong," "a little bit wrong," "wrong," and "very wrong." Dichotomous variables were created to compare the perception of "wrong/very wrong" and "not at all wrong/a little bit wrong."

Statistical Analyses

To answer the question about the prevalence of cigarette and e-cigarette use, the study sample included both middle school students ($n = 503$) and high school students ($n = 444$); this yielded a total sample size of 947 students. Descriptive statistics were used to explore associations between use and perceived risk of cigarettes and e-cigarettes with grade level. Given the relatively low prevalence of lifetime e-cigarette use among middle school students (4.6%; $n = 23$), the analysis of the correlates of e-cigarette use was restricted to the high school student sample ($n = 444$). Chi-square (χ^2) tests were used to identify differences between lifetime e-cigarette users and non-users on the basis of sociodemographic characteristics, substance use, and perceived risk variables.

Unadjusted and adjusted logistic regression analyses

were used to determine associations between the aforementioned characteristics and ever-use of e-cigarettes. Analyses were adjusted for race, grade, ever-use of cigarettes, ever-use of illicit drugs, ever-use of alcohol, perceived risk of e-cigarette use, and friends' perceived risk of e-cigarette use. Parental perceived risk of e-cigarette use, although significant in chi-square tests, was not included in further analyses because it perfectly predicted the outcome (ie, ever-use of e-cigarettes) and would not run in adjusted models. All analyses were conducted using STATA SE statistical software version 14.0.

Results

Characteristics of Middle School Students

Approximately half (49.1%) of middle school students were male; most (59.8%) were white; and 10.9% were Hispanic (see Table 1). A breakdown of middle school students by grade level showed that 33.0% of this group were

6th-grade students, 42.5% were 7th-grade students, and 24.5% were 8th-grade students. Approximately 4% of the middle school students had used e-cigarettes and combustible cigarettes during their lifetime, and 10.8% and 10.3% had used illicit drugs and alcohol, respectively, during their lifetime. Most (73.7%) perceived cigarette use to pose a great health risk, while 33.6% perceived e-cigarette use to pose a great health risk. The majority perceived that their friends (95.4%) and parents (95.3%) would perceive e-cigarette use to be wrong or very wrong.

Characteristics of High School Students

Compared to non-users, ever-users of e-cigarettes were more likely to be African American (13.6% versus 22.8%) and less likely to be Asian (16.0% versus 8.6%; χ^2 (3, N = 395) = 12.4; P = .006; see Table 1). A greater proportion of e-cigarette users than non-users reported Hispanic ethnicity (22.8% versus 15.2%; χ^2 (1, N = 438) = 4.0;

TABLE 1.
Characteristics of Middle School and High School Students Surveyed in the 2015 North Carolina Youth Risk Behavior Survey

Characteristic	Middle school students (n = 491)	High school students (n = 444)	High school students who had never used e-cigarettes (n = 279)	High school students who had used e-cigarettes (n = 165)	P-value
Sociodemographic characteristics					
Male	241 (49.1%)	250 (56.8%)	151 (54.7%)	99 (60.4%)	.247
Race					
White	280 (59.8%)	261 (66.1%)	169 (67.6%)	92 (63.4%)	.006
African American	51 (10.9%)	67 (17.0%)	34 (13.6%)	33 (22.8%)	
Asian	116 (24.8%)	51 (12.9%)	40 (16.0%)	11 (8.6%)	
Other	21 (4.5%)	16 (4.0%)	7 (2.8%)	9 (6.2%)	
Hispanic	54 (10.9%)	79 (18.0%)	42 (15.2%)	37 (22.8%)	.045
Grade					
6	163 (33.0%)	-	-	-	
7	210 (42.5%)	-	-	-	
8	121 (24.5%)	-	-	-	
9	-	133 (30.2%)	102 (36.8%)	31 (18.9%)	<.001
10	-	103 (23.4%)	68 (24.5%)	35 (21.3%)	
11	-	91 (20.6%)	47 (17.0%)	44 (26.8%)	
12	-	114 (25.8%)	60 (21.7%)	54 (32.9%)	
Lifetime drug use					
E-cigarettes	23 (4.6%)	165 (37.2%)	-	-	-
Combustible cigarettes	22 (4.4%)	96 (21.7%)	13 (4.7%)	83 (50.6%)	<.001
Cannabis	11 (2.2%)	150 (34.1%)	27 (9.7%)	123 (75.5%)	<.001
Cocaine	6 (1.2%)	22 (5.0%)	3 (1.1%)	19 (11.6%)	<.001
Inhalants	14 (2.8%)	26 (5.9%)	10 (3.6%)	16 (9.8%)	.008
Steroids	1 (0.20%)	8 (1.8%)	2 (0.7%)	6 (3.7%)	.026
Prescription drugs	12 (2.5%)	64 (14.7%)	12 (4.4%)	52 (31.9%)	<.001
Any drugs	54 (10.8%)	176 (39.6%)	48 (17.2%)	128 (77.6%)	<.001
Alcohol	51 (10.3%)	223 (50.4%)	86 (30.9%)	137 (83.5%)	<.001
Perceived risk					
Survey respondents perceived great risk of combustible cigarette use	368 (73.7%)	304 (69.4%)	195 (71.2%)	109 (66.5%)	.301
Survey respondents perceived great risk of e-cigarette use	166 (33.6%)	50 (11.3%)	45 (16.5%)	5 (3.0%)	<.001
Friends' perceived risk of e-cigarette use	473 (95.4%)	163 (37.4%)	150 (55.3%)	13 (7.8%)	<.001
Parents' perceived risk of e-cigarette use	470 (95.3%)	347 (79.0%)	249 (91.0%)	98 (59.4%)	<.001

Note. Bold text indicates statistically significant differences.

$P = .045$). There was a statistically significant association between being an ever-user of e-cigarettes and higher school grade; among those reporting ever-use of e-cigarettes, 18.9% were in 9th grade compared to 32.9% in 12th grade ($\chi^2 (3, N = 441) = 21.3; P < .001$).

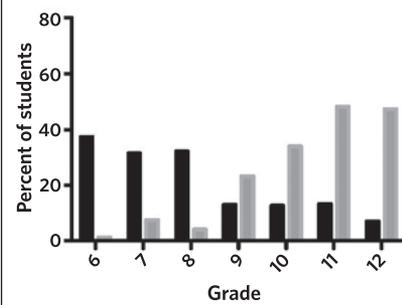
Ever-use of e-cigarettes (37.2%) was higher than ever-use of combustible cigarettes (21.7%), cannabis (34.1%), cocaine (5.0%), or other inhalants (5.9%). A greater proportion of e-cigarette users reported ever-use of cigarettes (50.6% versus 4.7%; $\chi^2 (1, N = 442) = 21.3; P < .001$), any illicit drugs (77.6% versus 17.2%; $\chi^2 (1, N = 444) = 157.9; P < .001$), and alcohol (83.5% versus 30.9%; $\chi^2 (1, N = 395) = 114.2; P < .001$).

Among both e-cigarette users and non-users, only 11.3% perceived “great risk” associated with e-cigarette use. Compared to non-users, e-cigarette users were less likely to perceive e-cigarette use as having great risk (16.5% versus 3.0%; $\chi^2 (1, N = 438) = 18.4; P < .001$). No significant differences were observed between e-cigarette users and non-users for perceived risk of combustible cigarette use (66.5% versus 71.2%; $\chi^2 (1, N = 438) = 1.1; P = .301$). Further, 37.4% of high school students self-reported the perception that their friends would feel that using e-cigarettes was wrong or very wrong. Compared with non-users, far fewer of those reporting ever-use of e-cigarettes felt that their friends would view e-cigarette use as wrong (55.3% versus 7.8%; $\chi^2 (1, N = 439) = 65.7; P < .001$). Similarly, while the majority (79.0%) of high school students reported the perception that their parents would feel it would be wrong or very wrong for them to use e-cigarettes, significantly fewer ever-users of e-cigarettes reported that they believed their parents would view their child’s e-cigarette use as wrong than did non-users (59.4% versus 91.0%; $\chi^2 (1, N = 439) = 61.6; P < .001$).

E-cigarette Use and Perceived Risk Among Middle and High School Students

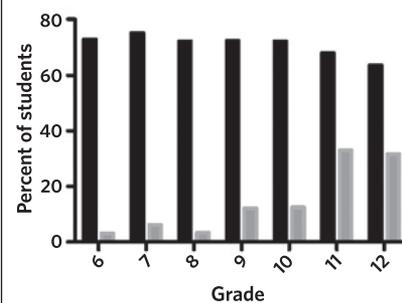
Of all the middle school students and high school students surveyed, 4.6% and 37.2% reported ever-use of e-cigarettes, respectively. Higher school grade increased the lifetime prevalence of both e-cigarette use (1.2%, 7.62%, 4.1%, 23.31%, 34.0%, 48.3%, 47.4%; $\chi^2 (6, N = 935) = 187.6; P < .001$) and combustible cigarette use (3.1%, 6.2%, 3.3%, 12.2%, 12.5%, 33.0%, 31.6%; $\chi^2 (6, N = 931) = 102.2; P < .001$). The perception of great risk associated with e-cigarette use decreased as grade level increased (37.4%, 31.5%, 32.2%, 13.0%, 12.9%, 13.3%, 7.1%; $\chi^2 (6, N = 923) = 67.3; P < .001$; see Figure 1A). In contrast, despite the increase in the prevalence of ever-use of combustible cigarettes as grade level increased, the overall perception of great risk associated with combustible cigarette use remained stable across grades (73.0%, 75.1%, 72.3%, 72.5%, 72.3%, 68.1%, 63.7%; $\chi^2 (6, N = 927) = 5.5; P = .478$; see Figure 1B).

FIGURE 1A.
Electronic Cigarette (E-Cigarette) Use and Self-Perceived Risk



Note. Gray bars show the percent of students who report ever-use of e-cigarettes. Black bars show the percent of students reporting that they perceive great risk of e-cigarette use.

FIGURE 1B.
Combustible Cigarette Use and Self-Perceived Risk



Note. Gray bars show the percent of students who report ever-use of combustible cigarettes. Black bars show the percent of students reporting that they perceive great risk of cigarette use.

Correlates of Lifetime E-cigarette Use Among High School Students

In adjusted analyses, ever-use of e-cigarettes was strongly associated with ever-use of combustible cigarettes (adjusted odds ratio [aOR] = 9.44; 95% confidence interval [CI], 3.78–23.59), ever-use of any illicit drugs (aOR = 6.43; 95% CI, 3.33–12.39), and ever-use of alcohol (aOR = 3.34; 95% CI, 1.61–6.95; see Table 2). Perceiving that friends would view the use of e-cigarettes as wrong was negatively associated with e-cigarette use (aOR = 0.43; 95% CI, 0.19–0.97).

Discussion

Our findings indicate that use of e-cigarettes among adolescents in North Carolina is substantially more prevalent than use of combustible cigarettes. Consistent with findings from the previous NYTS [4], the MTFs [6], the North Carolina Youth Tobacco Survey (NCYTS) [20], and the NCYRBS data [21], the prevalence of both combustible and e-cigarette use increased with higher grade level.

Our findings suggest that the use of e-cigarettes is

slightly more prevalent than was reported in the 2014 NYTS [4] and the 2015 MTF [6]. Other recent studies of adolescent populations in California [5, 11], Connecticut [22], and Florida [23] demonstrate similarly escalating use of e-cigarettes, which has eclipsed the use of combustible cigarettes among school-aged youth. Additionally, the high prevalence of e-cigarette use in our study sample may reflect the fact that historically North Carolina adolescents have consistently used tobacco products at rates higher than the national average [17, 24, 25].

Many have attributed the high rates of tobacco use in North Carolina to its traditional status as a leading tobacco producer, its consistently low ranking compared to other states in terms of tobacco-related excise taxes [18, 26], and its recent budget cuts for tobacco use prevention programs [27]. Further, while both cigarettes and e-cigarettes are now illegal for purchase by minors in North Carolina, taxes on e-cigarette liquids are significantly lower than on combustible cigarettes [28]. For these reasons, it has been posited that adolescents in our region may have a more favorable attitude toward tobacco products, including e-cigarettes [19]. It is not surprising, then, that our survey found a strong correlation between the use of e-cigarettes and the ever-use of combustible cigarettes. However, nearly half (49.4%) of the high school e-cigarette users in our study had not previously tried combustible cigarettes. Given that many students reported having used e-cigarettes but

not combustible cigarettes, health care professionals and public health administrators in North Carolina should have a low threshold for specifically addressing e-cigarette use with adolescents, independent of their use of other tobacco products.

Our study also observed that ever-users of e-cigarettes had significantly higher odds of having ever used alcohol and/or illicit drugs. This finding is consistent with previous studies that demonstrated an increased likelihood of use of alcohol, inhalants, cannabis, or sleeping pills among 10th-grade students in Iceland who used e-cigarette products, compared to their counterparts who did not use tobacco [29]. High school e-cigarette users in southern California also had a higher rate of reported delinquent behavior [11]. Interestingly, our finding that adolescent e-cigarette use is associated with use of other substances and delinquent behaviors is concordant with previous data suggesting a similar association between delinquent behaviors and the use of combustibles cigarettes and other tobacco products among adolescents [30]. One hypothesis for this association comes from the longstanding and well described concept of problem-behavior therapy (PBT), which proposes that substance use tends to be connected with certain personality traits (eg, personal leniency toward tobacco and other substance use) and other “delinquent behaviors” during adolescence [30, 31]. Through the framework of PBT, the demonstrated association of e-cigarette use with cannabis use in our study is interesting, with over 75% of the high school e-cigarette users in our sample also reporting cannabis use. Both e-cigarette use and cannabis use are known to be rising among adolescents nationally [4]—the 2015 MTF reported that cannabis was the 3rd most frequently vaporized substance among adolescents, behind nicotine and flavorings [6]—so future studies will need to more closely examine this association.

A low proportion of high school students in our sample perceived e-cigarette use as posing a significant risk. Beyond their own perceptions of risk, use of e-cigarettes was associated with adolescents’ perceptions of how their friends viewed the use of e-cigarettes. This observation is consistent with a recently published survey of high school students that demonstrated that the presence of a perceived “favorable e-cigarette social environment” and friendship with those who also used e-cigarettes were associated with a higher likelihood of using e-cigarettes [5].

Our study is the first to report on adolescents’ perceptions of their parents’ attitudes toward their child’s e-cigarette use; we found that fewer adolescents who had used e-cigarettes reported a perceived parental risk of these products, compared to those who had not used e-cigarettes. Indeed, the risk of adolescent e-cigarette use has been previously correlated with parental use of e-cigarettes and tobacco products [19]. Given the current promotion of e-cigarettes as a novel alternative to cigarettes and perhaps as an aid for smoking cessation [32], it is not surprising that

TABLE 2.
Unadjusted and Adjusted Logistic Regression Analyses

	Odds ratio (95% CI)	Adjusted odds ratio ^a (95% CI)
Race		
White	1.0	1.0
African American	1.78 (1.04-3.06)	1.40 (0.61-3.23)
Asian	0.50 (0.25-1.03)	0.64 (0.18-2.19)
Other	2.36 (0.85-6.55)	0.88 (0.13-5.77)
Ethnicity		
Non-Hispanic	1.0	1.0
Hispanic	1.65 (1.01-2.70)	2.44 (0.86-6.95)
Grade		
9	1.0	1.0
10	1.69 (0.95-3.00)	1.21 (0.51-2.89)
11	3.08 (1.73-5.47)	1.28 (0.50-3.31)
12	2.96 (1.72-5.10)	1.08 (0.45-2.58)
Ever-use of combustible cigarettes	20.89 (11.06-39.43)	9.44 (3.78-23.59)
Ever-use of illicit drugs	16.65 (10.30-26.91)	6.43 (3.33-12.39)
Ever-use of alcohol	11.33 (6.98-18.39)	3.34 (1.61-6.95)
Perceived great risk of e-cigarette use	0.16 (0.06-0.41)	0.24 (0.05-1.10)
Friends’ perceived risk of e-cigarette use	0.07 (0.04-0.13)	0.43 (0.19-0.97)

Note. CI, confidence interval.

Bold text indicates statistically significant findings.

^aAdjusted for race, ethnicity, grade, ever-use of cigarettes, ever-use of illicit drugs, ever-use of alcohol, perceived great risk of e-cigarette use, and friends’ perceived risk of e-cigarette use.

a general perception exists that e-cigarettes may be less harmful than combustible cigarettes [7]. In fact, nearly 60% of current youth combustible cigarette smokers surveyed in the NCYTS reported that they were attempting to quit smoking [24]. While recent studies of North Carolina youth have suggested that adolescents are perhaps less likely than adults to use e-cigarettes as part of an attempt to quit using tobacco products altogether [2], it is possible that a portion of the rise in e-cigarette use among youth may represent their attempt to mimic their parents' and peers' use of this more socially acceptable use of tobacco products.

Moreover, our findings revealed a correlation based on ascending grade level between a perception of decreased risk of e-cigarette use and an increasing prevalence of lifetime use of e-cigarettes. Conversely, although lifetime use of combustible cigarettes increased with advancing education level, risk perception of combustible cigarettes remained stable and high across all grades. This finding is concordant with those of similar recent surveys, which have noted a general consensus regarding perception among adolescents of the negative health effects of combustible cigarettes when they are presented with significant school and parental education on the topic.

Despite this finding, several factors appear to foster the use of e-cigarettes in this population, including an uncertainty about the risks of e-cigarettes, a reported number of social benefits associated with their use, and limited direct education on the potential risks of e-cigarettes [19, 33]. While the longitudinal risks associated with the use of e-cigarettes have yet to be determined, many have underscored the importance of developing public health measures and education programs on e-cigarettes targeted at the vulnerable adolescent population as part of an effort to combat the current observed rise in tobacco product use among youth [9, 19, 33-37]. Our survey results suggest that a critical time for adolescent education on this issue would be prior to high school matriculation, at which time the prevalence of ever-use of e-cigarettes surpasses perceived risk.

Our study has several strengths, including reporting of friends' and parents' perception of e-cigarette use with adjustment for confounding factors. However, the study also has several limitations. These include the self-reporting of results and the analysis of data from only a single school district, which limits generalizability of the findings. The frequency and specificity of e-cigarette and e-liquid use were also not determined in this study. Finally, we lacked data on the socioeconomic status of students participating in the survey.

Conclusion

Despite increasing legislative regulation of e-cigarettes in many states, including North Carolina [38, 39], ever-use of e-cigarettes among adolescents is high, and few high school students report perceiving risk associated with the use of e-cigarettes. Our results suggest that e-cigarette use

among adolescents correlates not only with their own risk perception of e-cigarette use but also with their view of their friends' perception of e-cigarette use. Our study suggests that the best time to influence adolescents' perceptions of e-cigarette risk by educating them and their parents about the health risks of e-cigarette use is prior to the transition to high school. Importantly, health care professionals in North Carolina should be aware of the high prevalence of e-cigarette use among middle school and high school students in our area and the need to address e-cigarette use among adolescents, independent of their use of other tobacco products. Future longitudinal studies are needed to determine whether the emerging favorable perception of e-cigarettes and the increased use of e-cigarettes among youth correlates with parental use, whether it leads to future use of other tobacco products, and whether any chronic health effects of e-cigarette use emerge in this vulnerable population. NCMJ

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