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Youth source of acquisition for E-Cigarettes

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ABSTRACT

As rates of traditional cigarette smoking have decreased among youth over the past several years, rates of e-cigarette use have increased. Little evidence exists on how youth obtain e-cigarettes. We used data from middle and high school students under the age of 18 who reported using an e-cigarette in the past 30 days from the 2017 North Carolina Youth Tobacco Survey (n = 640). We used chi-square tests and multivariable logistic regressions to examine correlates of access and place of acquisition. Over half (51.5%) of youth report acquiring e-cigarettes from a friend. Youth in 12th grade had higher odds of acquiring e-cigarettes from a vape shop (aOR: 2.54, 95% CI: 1.25, 5.15) or retail outlet (aOR: 2.40, 95% CI: 1.18, 4.90) than youth in middle school. Compared to non-Hispanic white youth, Hispanic youth had lower odds of acquiring e-cigarettes from a vape shop (aOR: 0.42, 95% CI: 0.20, 0.87). Youth living with someone who uses e-cigarettes, compared to those who did not, had higher odds of acquiring e-cigarettes from a family member (aOR: 3.95, 95% CI: 1.94, 8.05). Finally, current smokers had higher odds of acquiring e-cigarettes from a retail outlet (aOR: 3.28, 95% CI: 1.88, 5.70) and lower odds of acquiring e-cigarettes from a friend (aOR: 0.53, 95% CI: 0.36, 0.77). Youth primarily reported obtaining e-cigarettes from a friend. Living with someone who uses e-cigarettes may be a risk factor for acquiring e-cigarettes from family members. Identifying sources of e-cigarette acquisition will help inform interventions preventing youth e-cigarette access.

1. Introduction

As rates of traditional cigarette smoking have decreased among youth over the past several years, rates of electronic cigarette (e-cigarette) use have increased (Gentzke et al., 2019). This is of particular concern as recent research suggests that e-cigarette use, even among non-susceptible youth (Kowitz et al., 2018), may lead to later cigarette use (Bold et al., 2018; Chaffee et al., 2018). Adolescent brains are particularly susceptible to the adverse effects of nicotine (which is found in most e-cigarettes), (England et al., 2015; U.S. Department of Health and Human Services, 2016; Yuan et al., 2015) and adolescent exposure to nicotine has the potential to increase susceptibility to substance abuse later in life (Yuan et al., 2015). Moreover, youth who are susceptible, experiment, and initiate use of e-cigarettes perceive e-cigarettes to be less harmful and addictive than traditional cigarettes (Bernat et al., 2018; Lechner et al., 2018).

Research shows that youth get their tobacco products from multiple

sources, either commercial (i.e., buying them in stores or online) or social (i.e., parents, siblings, friends, etc.) (Dai and Hao, 2018). While a large amount of research exists to identify where youth obtain cigarettes and other tobacco products (Castrucci et al., 2002; Forster et al., 2003; Lipperman-Kreda et al., 2015; Meyers et al., 2017; Trapl et al., 2015), little evidence exists describing where youth obtain e-cigarettes (Kong et al., 2017; Mantey et al., 2019; Meyers et al., 2017; Pepper et al., 2019). Differentiating between traditional tobacco product and e-cigarette access is important for a few reasons, one of which is that the traditional tobacco product literature does not include vape shops. Only two of the four existing studies that examine e-cigarette access asked specifically about vape shops, and results differentiated greatly (3.8% versus 22.3% of respondents identifying vape shops as a source of acquisition) (Kong et al., 2017; Pepper et al., 2019). Acquisition from vape shops have particular relevance considering a recent proposed policy from the US Food and Drug Administration (FDA) that would effectively ban the sale of flavored e-cigarettes from anywhere except

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vape shops and other adult-only retailers (U.S. Food and Drug Administration, 2019). The wide variety of flavors available in e-cigarettes (which are no longer available in cigarettes) may be particularly appealing to youth, and are cited as a primary reason for use among youth in many studies (Huang et al., 2017; Meernik et al., 2019). In fact, one study showed that 78% of youth reported that they would not use an e-cigarette if it were not flavored. Understanding where youth obtain their e-cigarettes, particularly if they obtain them from vape shops, has useful regulatory implications.

One method to help prevent youth initiation and use of e-cigarettes involves limiting youth access to e-cigarettes, including through stores and on-line purchases. Results from one recent study suggest that access to e-cigarettes from retail sources is associated with e-cigarette use among youth (Mantey et al., 2019). However, apart from examining retail sources of e-cigarettes, it is important to distinguish source of acquisition of e-cigarettes compared to traditional tobacco products because patterns of use for e-cigarettes differs from that of traditional products; the social nature of borrowing and passing around vaping devices differs from that of traditional tobacco products, and could potentially mean that youth do not necessarily need to acquire and own their own e-cigarettes in order to use them (Pepper et al., 2019). Therefore, the scant literature available to describe where youth are accessing their e-cigarettes, whether from retail or social sources, is insufficient to provide context for the exponential increase in youth use of these products. This paper seeks to provide necessary evidence for where youth acquire e-cigarettes, describing the current source of acquisition for e-cigarettes among North Carolina youth.

2. Methods

2.1. Settings, Participants, procedures

We used data from the 2017 North Carolina Youth Tobacco Survey (NCYTS). Similar to the National Youth Tobacco Survey (NYTS), which is validated by the Centers for Disease Control and Prevention, (Centers for Disease Control and Prevention, 2018) the NCYTS is a public and charter school-based survey of students in grades 6–12. A multi-stage cluster sampling design in three distinct regions of the state was used. School districts were first selected within three geographic regions of the state; a school's probability for selection was proportional to its enrollment size for the survey year. Classes were then randomly selected within each school. Participation was voluntary and anonymous. Passive consent forms were utilized, unless an active consent form was required according to a specific school district policy. Response rate was calculated by multiplying the school response rate (i.e. percent of schools that participated) by the student response rate (i.e. percent of students that participated). Weighting of each questionnaire allowed us to reflect the likelihood of sampling each student and to reduce bias by compensating for differing patterns of nonresponse. The overall response rate was 64.5% for high school students (75.2% school response rate, 85.8% student response rate) and 65.4% for middle school students (76.3% school response rate, 85.7% student response rate). For analytical purposes, we combined high school and middle school samples. As this article utilized a secondary, de-identified dataset, IRB approval was not sought.

2.2. Measures

2.2.1. Study sample

Since we were interested in how youth acquired e-cigarettes, analyses were restricted to youth who reported ever use of an e-cigarette and use in the past 30 days. Though we used grade rather than age in our analyses, the age range of our sample was 9–17 years. Of the 3200 middle school students who completed the NCYTS, 5.3% ($n = 175$) reported ever using e-cigarettes and using them in the past 30 days. Of the 3133 high school students who completed the NCYTS, 16.9%

($n = 575$) reported ever using e-cigarettes and using them in the past 30 days. In the total sample ($n = 6333$), after removing participants who reported not using an e-cigarette in the past 30 days ($n = 5583$), youth who reported being age 18 and over (because they can legally purchase tobacco products) ($n = 42$), and observations with missing data on any of the other variables examined ($n = 68$), a total of 640 adolescents were included in analyses.

2.2.2. Access to e-cigarettes

Our main outcome of interest was access to e-cigarettes. Adolescents were asked, "In the past 30 days, where did you get or buy the e-cigarettes that you have used?" Participants could choose one or more of the following response options: 1) I have never tried an e-cigarette in the past 30 days, 2) A gas station or convenience store, 3) A grocery store, 4) A drugstore, 5) A mall or shopping center kiosk/stand, 6) On the Internet, 7) A vape shop or other store that only sells e-cigarettes, 8) Some other place not listed here, 9) From a family member, 10) From a friend, and 11) From some other person that is not a family member or a friend. If participants selected "Yes" to the first response option ("I have never tried an e-cigarette in the past 30 days"), their data were excluded from analyses. We collapsed responses 2–5 into one category, since few people chose these options and they were conceptually related to one another, which we labeled "a retail location." We analyzed each of the remaining response options as separate variables, including vape shops, which represent a novel location of potential acquisition that is not examined in traditional cigarette purchase literature.

2.2.3. Correlates

We assessed demographic variables, whether participants lived with someone who uses e-cigarettes, and whether participants reported smoking cigarettes in the past 30 days as correlates. Demographic variables included sex, grade, and race/ethnicity. We collapsed categories for grade to include: middle school (6th, 7th, and 8th), 9th, 10th, 11th, and 12th since few middle school youth reported currently using e-cigarettes.

2.2.4. Statistical analysis

We first examined correlates of access to e-cigarettes using chi-square tests. We then conducted four separate multivariable logistic regressions, using the following four outcomes—whether or not adolescents got or bought e-cigarettes from 1) a friend, 2) a vape shop, 3) a family member, or 4) a retail location. We chose these four outcomes since they were the most commonly reported places or sources through which youth had access to e-cigarettes in the present sample. Analyses used SAS version 9.4 survey procedures (SAS Inc., Cary, NC, USA). We set critical $\alpha = 0.05$ and used 2-tailed statistical tests. Results include weighted percentages, adjusted odds ratios (aOR), and 95% confidence intervals (CI).

3. Results

3.1. Participant characteristics

Among the 640 adolescents who reported currently using e-cigarettes, the majority identified as non-Hispanic White (68.1%) and male (54.0%) (Table 1).

A quarter of youth reported living with someone who uses e-cigarettes (26.1%). The most common location or source for getting e-cigarettes was a friend (51.5%), followed by a family member (16.4%), a vape shop (16.2%), and a retail location (12.3%) (Fig. 1).

Few adolescents reported getting e-cigarettes from another person that was not a family member or a friend (6.1%), the Internet (3.8%), or another place not listed (3.5%). The majority of adolescents reported getting e-cigarettes from one place (92%, data not shown).

Table 1
Participant characteristics, among current e-cigarette users, n = 640, from the North Carolina Youth Tobacco Survey, 2017.

Variable	Unweighted n (Weighted %)
Sex	
Female	293 (46.0)
Male	347 (54.0)
Grade	
6th, 7th, or 8th	150 (17.6)
9th	125 (17.2)
10th	135 (21.7)
11th	107 (24.0)
12th	123 (19.5)
Race	
Non-Hispanic White	422 (68.1)
Non-Hispanic Black	76 (11.8)
Hispanic	109 (14.0)
Non-Hispanic other	33 (6.1)
Lives with someone who uses e-cigarettes	
No	483 (74.4)
Yes	169 (26.1)
Currently smokes cigarettes [participant]	
No	471 (73.9)
Yes	169 (26.1)

3.2. Bivariate associations

Bivariate results are reported in Table 2.

3.2.1. Friends

Grade (p = 0.04), living with someone who uses e-cigarettes (p = 0.02), and current smoking status (p < 0.001) were associated with getting or buying e-cigarettes from a friend. Specifically, a greater proportion of youth in 9th (64.7%) and 10th (57.3%) grade reported getting or buying e-cigarettes from a friend, compared to youth in middle school (43.4%), 11th grade (50.1%) and 12th grade (42.4%). In addition, a greater proportion of youth who do not live with someone who uses e-cigarettes (55.3%) reported getting or buying e-cigarettes from a friend, compared to youth who live with someone who uses e-cigarettes (40.4%). In addition, a greater proportion of non-current smokers (55.9%) reported getting or buying e-cigarettes from a friend, compared to current smokers (39.0%).

3.2.2. Family members

Living with someone who uses e-cigarettes (p < 0.001) was

associated with getting or buying e-cigarettes from a family member. Specifically, a greater proportion of youth who lived with someone who uses e-cigarettes reported getting or buying e-cigarettes from a family member (32.4%), compared to those not living with someone who uses e-cigarettes (10.9%). In addition, a higher proportion of youth in middle school appeared to have gotten or bought e-cigarettes from a family member (30.5%) compared to youth in other grades (ranging from 12.9% to 14.4%), though this difference was not statistically significant (p = 0.10).

3.2.3. Vape shop

No variables were statistically significantly associated with getting or buying e-cigarettes from a vape shop; however, there appeared to be a higher rate of getting or buying e-cigarettes from a vape shop among youth in older grades. Specifically, a greater proportion of 12th grade youth (22.6%) got or bought e-cigarettes from a vape shop compared to youth in younger grades (ranging from 9.2% among middle school students to 18.7% among 10th grade students) (p = 0.09). In addition, more non-Hispanic White youth (18.7%) appeared to have procured e-cigarettes from a vape shop than youth of other races (ranging from 8.1% among Hispanic youth to 16.3% among non-Hispanic youth) (p = 0.08). Finally, it appeared that a greater proportion of current smokers (20.3%) got or bought e-cigarettes from a vape shop than non-current smokers (14.7%), although this difference was not statistically significant (p = 0.07).

3.2.4. Retail location

Current smoking status (p < 0.001) was significantly associated with getting or buying e-cigarettes from a retail location. Specifically, a greater proportion of current smokers (22.6%) reported getting or buying e-cigarettes from a retail location, compared to non-current smokers (8.6%).

3.3. Multivariable associations

Multivariable results are reported in Table 3.

3.3.1. Friends

Youth in 9th grade (aOR: 2.12, 95% CI: 1.03, 4.37) had higher odds of getting or buying e-cigarettes from a friend than adolescents in middle school. Additionally, non-Hispanic Black youth (aOR: 0.53, 95% CI: 0.29, 0.94), youth who lived with someone who uses e-cigarettes (aOR: 0.54, 95% CI: 0.32, 0.89), and youth who currently smoked e-cigarettes (aOR: 0.53, 95% CI: 0.36, 0.77) had lower odds of getting or

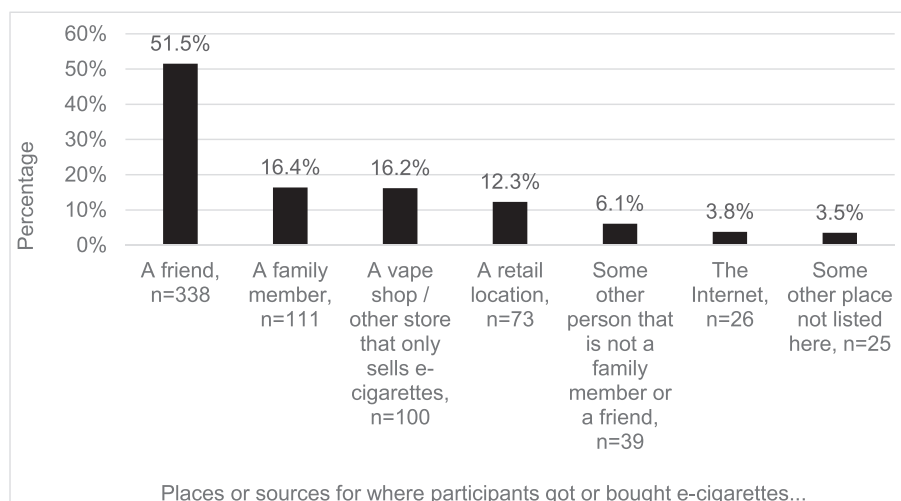


Fig. 1. Source of acquisition for e-cigarettes in the past 30 days, among current e-cigarette users, n = 640, from the North Carolina Youth Tobacco Survey, 2017.

Table 2
Bivariate associations among correlates and the top three most common places or sources for adolescents' access to e-cigarettes, among current e-cigarette users, n = 640, from the North Carolina Youth Tobacco Survey, 2017.^{a,b}

	Did not get or buy e-cigarettes from a friend (n = 302, 48.5%)	Got or bought e-cigarettes from a friend (n = 338, 51.5%)	p-value ^c	Did not get or buy e-cigarettes from a family member (n = 529, 83.6%)	Got or bought e-cigarettes from a family member (n = 111, 16.4%)	p-value ^c	Did not get or buy e-cigarettes from a vape shop (n = 540, 83.8%)	Got or bought e-cigarettes from a vape shop (n = 100, 16.2%)	p-value ^c	Did not get or buy e-cigarettes from a retail location (n = 567, 87.7%)	Got or bought e-cigarettes from a retail location (n = 73, 12.3%)	p-value ^c
Sex												
Female	134 (46.1)	159 (53.9)	p = 0.42	227 (81.5)	66 (18.5)	p = 0.36	252 (84.9)	41 (15.1)	p = 0.48	265 (89.7)	28 (10.3)	p = 0.23
Male	168 (50.4)	179 (49.6)		302 (85.4)	45 (14.6)		288 (82.9)	59 (17.1)		302 (86.1)	45 (13.9)	
Grade												
6th, 7th, or 8th	79 (56.6)	71 (43.4)	p = 0.04	101 (69.5)	49 (30.5)	p = 0.10	138 (90.8)	12 (9.2)	p = 0.09	138 (92.1)	12 (7.9)	p = 0.16
9th	48 (35.3)	77 (64.7)		107 (87.1)	18 (12.9)		110 (88.7)	15 (11.3)		118 (94.5)	7 (5.5)	
10th	53 (42.7)	82 (57.3)		115 (86.8)	20 (13.2)		112 (81.3)	23 (18.7)		119 (87.3)	16 (12.7)	
11th	55 (49.9)	52 (50.1)		92 (86.8)	15 (13.2)		88 (82.7)	19 (17.3)		89 (83.0)	18 (17.0)	
12th	67 (57.6)	56 (42.4)		114 (85.6)	9 (14.4)		92 (77.4)	31 (22.6)		103 (84.2)	20 (15.9)	
Race												
Non-Hispanic White	182 (45.4)	240 (54.6)	p = 0.18	359 (85.2)	63 (14.8)	p = 0.44	349 (81.3)	73 (18.7)	p = 0.08	377 (88.1)	45 (11.9)	p = 0.65
Non-Hispanic Black	47 (56.6)	29 (43.4)		56 (78.3)	20 (21.7)		65 (88.8)	11 (11.2)		65 (85.5)	11 (14.5)	
Hispanic	53 (49.9)	56 (50.1)		89 (82.3)	20 (17.7)		100 (91.9)	9 (8.1)		94 (85.0)	15 (15.0)	
Non-Hispanic other	20 (63.5)	13 (36.5)		25 (78.8)	8 (21.2)		26 (83.7)	7 (16.3)		31 (94.0)	2 (6.0)	
Lives with someone who uses e-cigarettes												
No	213 (44.6)	270 (55.3)	p = 0.02	422 (89.1)	61 (10.9)	p < 0.001	410 (84.3)	73 (15.7)	p = 0.53	428 (87.9)	55 (12.1)	p = 0.89
Yes	89 (59.6)	68 (40.4)		107 (67.6)	50 (32.4)		130 (82.4)	27 (17.6)		139 (87.4)	18 (12.6)	
Currently smokes cigarettes												
No	203 (44.1)	268 (55.9)	p < 0.001	387 (83.1)	84 (16.9)	p = 0.68	407 (85.3)	64 (14.7)	p = 0.07	431 (91.4)	40 (8.6)	p < 0.001
Yes	99 (61.0)	70 (39.0)		142 (85.0)	27 (15.0)		133 (79.7)	36 (20.3)		136 (77.4)	33 (22.6)	

^a Cells with < 50 participants should be interpreted with caution.
^b Percentages provided are row percentages, i.e., the percentage included in the cell in the first column and first row indicates that among females, 46.1% did not get or buy e-cigarettes from a friend (compared to the overall average of 48.5%).
^c p-values are from chi-square tests.

Table 3
Multivariable associations among correlates and the top three most common places or sources for adolescents' access to e-cigarettes, among current e-cigarette users, n = 640, from the North Carolina Youth Tobacco Survey, 2017.

	Got or bought e-cigarettes from a friend (n = 338) vs. not (n = 302)aOR (95% CI)	Got or bought e-cigarettes from a family member (n = 111) vs. not (n = 529)aOR (95% CI)	Got or bought e-cigarettes from a vape shop (n = 100) vs. not (n = 540)aOR (95% CI)	Got or bought e-cigarettes from a retail outlet (n = 73) vs. not (n = 567)aOR (95% CI)
Male (ref. female)	0.81 (0.52, 1.24)	0.79 (0.42, 1.47)	1.19 (0.76, 1.87)	1.34 (0.75, 2.40)
9th grade (ref. middle school)	2.12 (1.03, 4.37)	0.39 (0.17, 0.93)	1.21 (0.53, 2.74)	0.85 (0.19, 3.73)
10th grade (ref. middle school)	1.60 (0.90, 2.84)	0.37 (0.15, 1.01)	2.04 (0.97, 4.29)	2.03 (0.98, 4.22)
11th grade (ref. middle school)	1.13 (0.62, 2.06)	0.45 (0.23, 0.87)	1.85 (0.77, 4.42)	2.73 (0.98, 7.62)
12th grade (ref. middle school)	0.85 (0.43, 1.70)	0.46 (0.12, 1.81)	2.54 (1.25, 5.15)	2.40 (1.18, 4.90)
Non-Hispanic Black (ref. Non-Hispanic White)	0.53 (0.29, 0.94)	1.78 (0.92, 3.45)	0.65 (0.27, 1.60)	1.88 (0.64, 5.51)
Hispanic (ref. Non-Hispanic White)	0.87 (0.55, 1.39)	1.09 (0.52, 2.29)	0.42 (0.20, 0.87)	1.44 (0.69, 3.02)
Non-Hispanic Other (ref. Non-Hispanic White)	0.48 (0.17, 1.32)	1.29 (0.54, 3.12)	0.93 (0.34, 2.55)	0.45 (0.07, 2.02)
Lives with someone who uses e-cigarettes (ref. no)	0.54 (0.32, 0.89)	4.00 (1.93, 8.20)	1.15 (0.70, 1.88)	1.07 (0.57, 2.02)
Currently smokes cigarettes (ref. no)	0.53 (0.36, 0.77)	0.78 (0.36, 1.69)	1.42 (0.87, 2.30)	3.28 (1.88, 5.70)

Note: Boldface indicates p < 0.05, columns represent 4 separate regression models.

buying e-cigarettes from a friend, compared to non-Hispanic White youth, youth who did not live with someone who uses e-cigarettes, and non-current smokers, respectively.

3.3.2. Family

Youth in 9th (aOR: 0.39, 95% CI: 0.17, 0.93) and 11th grade (aOR: 0.45, 95% CI: 0.23, 0.87) had lower odds of getting or buying e-cigarettes from a family member than youth in middle school. Youth who lived with someone who uses e-cigarettes had higher odds of getting or buying e-cigarettes from a family member (aOR: 4.00, 95% CI: 1.93, 8.20) than youth who did not live with someone who uses e-cigarettes.

3.3.3. Vape shops

Youth in 12th grade had higher odds of getting or buying e-cigarettes from a vape shop (aOR: 2.54, 95% CI: 1.25, 5.15) compared to youth in middle school. In addition, Hispanic youth had lower odds of getting or buying e-cigarettes from a vape shop (aOR: 0.42, 95% CI: 0.20, 0.87), than non-Hispanic White youth.

3.3.4. Retail location

Youth in 12th grade (aOR: 2.40, 95% CI: 1.18, 4.90) and current smokers (aOR: 3.28, 95% CI: 1.88, 5.70) had higher odds of getting or buying e-cigarettes from a retail location, compared to youth in middle school and non-current smokers, respectively.

4. Discussion

There are multiple sources from which youth obtain e-cigarettes, suggesting the need for a multi-pronged approach for preventing and reducing youth access to these products. Youth primarily reported getting their e-cigarettes from friends, followed by family members, vape shops, and retail locations. Results also indicate that current smokers were more likely to get their e-cigarettes from a retail location compared to non-current smokers, bolstering evidence that youth who smoke cigarettes may be more comfortable bypassing age restrictions than non-smoking youth (Meyers et al., 2017). Additionally, our data are fairly consistent with though do not precisely mimic national rates reporting e-cigarette use in the last 30 days: 5.3% for middle schoolers (compared to 4.9% nationally), and 16.9% for high schoolers (compared to 20.8% nationally) (Gentzke et al., 2019). The fact that we excluded 18 year-olds, and national data sets do not, may account for the latter discrepancy.

Traditional cigarette acquisition literature suggests that younger youth are more likely to get their cigarettes from social sources, likely because they are not able to purchase as easily from retail locations (Lee et al., 2016). This may also be true for e-cigarettes, though not enough research currently exists to explore this relationship specific to e-cigarettes. It is also important to consider these results in the wider scope of e-cigarette vaping culture and how that differs from traditional tobacco product use; recent research suggests that borrowing and sharing vaping devices is much more common among adolescents compared to traditional tobacco products (Pepper et al., 2019). This may result in a lower barrier to entry (i.e., barrier to initiation of vaping) for many youth. For example, youth may find it easier to try vaping if they do not need to own their own device because they are sharing or borrowing from friends. In addition, these data were collected during the exponential rise in rates of the use of JUUL and other pod-type devices among youth; these devices may have been more readily available through certain sources compared to others (e.g. more available at gas stations vs. vape shops). Additional research should explore this relationship, as JUUL now owns a very large portion of the e-cigarette market share (Huang et al., 2018).

Results from this study also show that living with someone who uses e-cigarettes increases odds that youth are obtaining their e-cigarettes from family members. Though no studies have specifically explored this, it is possible that family members provide e-cigarettes to youth

because they think they are safer than regular cigarettes, (Kong et al., 2017) which is a primary reason many adult smokers use e-cigarettes themselves (Patel et al., 2016). Our results do not distinguish whether these adolescents were given e-cigarettes by family members or if they took them from family members. Nevertheless, this source of acquisition has important implications for interventions related to adult education and marketing of e-cigarettes.

Our results indicate that grade was associated with purchasing from retail locations and vape shops, with adolescents in 12th grade being more likely to obtain e-cigarettes from vape shops than younger grades. This is fairly consistent with the cigarette purchase literature, which suggests that younger youth are less likely to be successful in their purchase attempts compared to their older peers (Lee et al., 2016; The Institute of Medicine, 2015). Though recent research suggests that youth are equally able to purchase e-cigarettes as cigarettes from retail venues, (Levinson, 2018) trends over time have shown that youth are becoming increasingly less likely to purchase tobacco products from stores, and instead, they are obtaining them from social sources, likely due to more restrictive access policies (Dai and Hao, 2018; Jones et al., 2002). As such, enforcement efforts by the US Food and Drug Administration (FDA) and the Synar Amendment (a federal program beginning in 1992 requiring states to pass laws and meet compliance performance targets reducing youth access) (U.S. Food and Drug Administration, 2010) can and will be only so effective in discouraging youth access to and use of tobacco products and e-cigarettes.

A new variable that cannot be assessed in the traditional cigarette purchase literature are vape shops; only two studies to date have asked youth about purchasing at vape shops and there are conflicting results about the popularity of this location for youth purchasing (Kong et al., 2017; Pepper et al., 2019). Although not statistically significant, our results trend towards showing that older youth in 12th grade were more likely to purchase their e-cigarettes from vape shops than those in younger grades. It's possible that older youth are more comfortable fitting in with the social "vibe" procured by vape shops and lounges (where use of e-cigarettes is permitted and encouraged); (Kong et al., 2017) more research should explore the appeal of this atmosphere to youth. Similarly, a relationship that cannot be examined in the traditional cigarette purchase literature is that between smoking status and location of acquisition of e-cigarettes by underage youth. Our results indicate that youth who currently smoke cigarettes are more likely to obtain their e-cigarettes from retail locations and less likely to get them from a friend. This is likely because adolescents who smoke may be more comfortable circumventing age restrictions for their cigarettes, and thus apply those same tactics to procuring their e-cigarettes. Only one other study has examined this, and its shows similar results (Kong et al., 2017).

This research suggests the need for different types of e-cigarette policy interventions to reduce youth access to and use of e-cigarettes. With the exception of Pennsylvania, all states currently have laws restricting youth access to e-cigarettes. (Public Health Law Center, 2019a) In North Carolina, those restrictions are placed on selling or distributing vapor products to youth under the age of 18; purchase of vapor products by those under 18 is also prohibited (Public Health Law Center, 2019b). The results of this work may bolster evidence for an existing movement in the field of tobacco control, which is to raise the minimum legal sales age of tobacco products from 18 to 21. Fifteen states (including the District of Columbia) have already done so; four have raised it to 19. (Public Health Law Center, 2019a) This movement is largely based on the premise that by increasing the age of sale to 21, you are reducing the availability of tobacco products to adolescents who are slightly under the age limit from peers that are slightly over (Meernik et al., 2017; The Institute of Medicine, 2015). In fact, evidence suggests that increasing the minimum legal sales age of tobacco to 21 would reduce initiation of tobacco use particularly among those aged 15 to 17 (The Institute of Medicine, 2015). While the FDA has had regulatory authority over e-cigarettes since 2016, (U.S. Food and Drug

Administration, 2016) they do not have the authority to raise the minimum legal age of tobacco products. Thus, the impetus is on state and local authorities to enact legislation that increases the minimum legal sales age of tobacco products, when they are not preempted from doing so by state law (Meernik et al., 2017).

The FDA does have the authority to regulate e-cigarette sales more closely, including at both vape shops (a commonly cited source of acquisition among this group) and via internet sales, which have been shown to be an easy point of access for youth in purchasing their e-cigarettes (Williams et al., 2015). Recently, the FDA announced efforts to restrict young people under age 18 from accessing flavored e-cigarette products via retail establishments and online websites. While no details were mentioned about specific efforts, FDA is urging manufacturers to "police themselves" and voluntarily remove flavored electronic cigarette products where young people cannot access them (Kaplan and Hoffman, 2018). Other interventions, including more prohibitive restrictions on marketing and advertisements, effective e-cigarette health warnings and messages, (Meernik et al., 2017; U.S. Department of Health and Human Services, 2016) removal of flavors, (Camenga et al., 2018; Harrell et al., 2017; Huang et al., 2017) as well as tobacco retail licensing (Lipperman-Kreda et al., 2015) could help to reduce youth access to and use of tobacco products and in particular, e-cigarettes.

This study is not without limitations. Though representative of students in public schools in North Carolina, the sample is only of one state. All data are cross-sectional and we could not examine trends over time in access to e-cigarettes. All results are self-reported, which means that they are prone to recall errors or other potential response biases. School participation is anonymous and was not analyzed for non-response bias. However, survey results are weighted to be representative of the entire state, so individual school participation does not affect generalizability of the survey results. The survey did not assess whether youth obtained specific types of e-cigarettes from different locations or sources. Finally, the survey question and data focuses on past 30-day acquisition, thus may not capture location of acquisition for all e-cigarettes being used by youth.

5. Conclusions

Youth primarily reported obtaining e-cigarettes from a friend. Living with someone who uses e-cigarettes may be a risk factor for acquiring e-cigarettes from family members and underage, current smokers may be more likely to purchase their e-cigarettes than obtain them from social sources. As the very few other studies on this topic suggest, more research is needed to provide evidence for where youth are obtaining their e-cigarettes. Additionally, more exploration into vaping culture, specifically how youth borrow and share vaping devices, is needed to more fully understand how youth are initiating and maintaining vaping behaviors (Pepper et al., 2019). Having this information will support and inform specific messaging, interventions, regulation, and enforcement of e-cigarette acquisition among youth.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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