

Impact of School Tobacco-Free Policy and Tobacco Risk Education on Youth Cigarette and E-Cigarette Use

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ABSTRACT

Background: Smoking rates have declined over the last half-century, however, e-cigarette use has more than tripled in the recent years. Tobacco-risk education and tobacco-free policies are critical policy instruments to help prevent youth tobacco use. This study evaluates the impact of these policies on youth cigarette and e-cigarette use.

Methods: Data from the 2013/2015 Georgia Youth Tobacco Survey (GYTS) is used to test for statistical differences in tobacco use status across school-based tobacco control policies and estimate their impact on cigarette and e-cigarette use. Data includes 5,285 participants representing 2013 middle school (n=2,099), 2013 high school (n=1,775), and 2015 high school (n=1,411). Current cigarette and e-cigarette use is measured as having used them in the past month. Students were asked if their school has a tobacco-free policy and if they were taught in classes about why they should not use tobacco. Multivariate logistic regression and Chi-squared tests are used to analyze data.

Results. The use of cigarettes among high school students has decreased, however the use of e-cigarettes has increased. Strong statistical associations exist between tobacco-use behavior and tobacco-control policies, however, these associations were not consistent across all cohorts. Smoking disparities exist where males, White and Hispanic students smoked at much higher rates.

Conclusions. The rise of e-cigarette popularity may have significant health effects and become a gateway to smoking cigarettes. The positive impact of tobacco-free policies on youth cigarette use is counter-intuitive and may be the result of adoption of tobacco-free policies by the schools where tobacco use is of a significant concern, hence, higher smoking rates. Future research should examine the effects of these policies, their enforcement, and length of existence in detail to provide more evidence into the effectiveness of these policies.

Keywords: Tobacco-free policy, tobacco-risk education, youth, smoking

INTRODUCTION

Tobacco use is the primary cause of lung cancer and the leading cause of preventable and premature death in the United States (U.S. Department of Health and Human Services, 2014; Xu, Bishop, Kennedy, Simpson, & Pechacek, 2015). Nearly all tobacco use behavior and habit formation begins during youth and early adulthood, with 90% of smoking initiation and progression to daily smoking occurring primarily by age 18 (Jamal et al., 2017; U.S. Department of Health and Human Services, 2014). Tobacco use can become a lifetime pattern thus significantly impacting an individual's health, including tobacco-caused diseases (Tobacco Free Kids, 2016). Tobacco use in any form is unsafe for youth (U.S. Department of Health and Human Services, 2014, 2016), and this includes e-cigarettes, which may not only be harmful, but may also become a

gateway to other forms of tobacco use for middle and high school students and may discourage smokers to quit (Brandon et al., 2015; Makadia, Roper, Andrews, & Tingen, 2017; Primack, Soneji, Stoolmiller, Fine, & Sargent, 2015).

Each day in the United States, more than 3,200 youth aged 18 years or younger smoke their first cigarette and an additional 2,100 youth and young adults become daily cigarette smokers (U.S. Department of Health and Human Services, 2014). Even though tobacco use has declined among youth and adults over the last half-century (Jamal et al., 2016; U.S. Department of Health and Human Services, 2014), e-cigarette use is increasing at alarming rates among youth (Centers for Disease Control and Prevention, 2015a, 2015b), young adults (Agaku et al., 2014; Schoenborn &

Gindi, 2015), and adults (Ayers, Ribisl, & Brownstein, 2011; Regan, Promoff, Dube, & Arrazola, 2013; Schoenborn & Gindi, 2015). As a result, recent literature (Hines, Fiala, & Hedberg, 2017; Singh et al., 2016) indicates that the increased popularity and use of e-cigarettes has offset the substantial declines in cigarette and other conventional tobacco use among youth over the past few decades. The National Youth Tobacco Survey (NYTS) reports that in 2016, 20.2% of high school students and 7.2% of middle school students were tobacco users, with nearly half of them using more than two tobacco products. E-cigarettes were the most commonly used tobacco product among high (11.3%) and middle (4.3%) school students (Jamal et al., 2017).

Youth and young adults are shown to be at increased risk of using e-cigarettes (Cobb & Abrams, 2011; Pearson, Richardson, Niaura, Vallone, & Abrams, 2012; Regan et al., 2013). They are often drawn to novel products and are more accepting of e-cigarette use in public as compared to public cigarette smoking (Trumbo & Harper, 2013). Recent research suggests that e-cigarettes are perceived as less harmful and easier to access than conventional cigarettes (Hammal & Finegan, 2016; Tan & Bigman, 2014). In particular, youth might not have adequate education about e-cigarettes (Hammal & Finegan, 2016; Sanders-Jackson, Tan, Bigman, & Henriksen, 2015), as significant numbers of youth believe that e-cigarettes are less harmful (73%) and less addictive (47%) than traditional cigarettes (Amrock, Lee, & Weitzman, 2016) and think that e-cigarette harm is dose-dependent (Ambrose et al., 2014). This is possibly due to marketing efforts, as e-cigarettes are aggressively sold as a 'healthier alternative' to traditional cigarettes, are advertised as cessation aids, and are publicized by the e-cigarette industry for use anywhere (Brown et al., 2014; Rahman, Hann, Wilson, Mnatzaganian, & Worrall-Carter, 2015). Other studies have found that exposure to e-cigarette advertisements may lead to an interest to try cigarettes (Kim et al., 2013) and e-cigarettes (Smith, Bansal-Travers, O'Connor, Goniewicz, & Hyland, 2015). Youth and young adults with lower harm perception have an increased interest in trying e-cigarettes (Choi, Fabian, Mottey, Corbett, & Forster, 2012) and are more likely to use e-cigarettes (Czoli, Hammond, & White, 2014; Saddleson et al., 2015) and transition to traditional cigarettes (Leventhal et al., 2015; Primack et al., 2015).

Adolescents and youth spend a considerable amount of time at primary and secondary schools where they are also exposed to peer pressure regarding tobacco use behaviors (Tobacco Free Kids, 2018). The Centers for Disease Control and Prevention (CDC) (1994) has identified schools as uniquely and powerfully positioned to nudge youth towards realizing the harms and consequences of tobacco products. As a result, in collaboration with experts from various national, federal, and volunteer agencies, the CDC has developed a set of school-based strategies most likely to be effective in preventing tobacco use among youth. Some of

these strategies center on providing comprehensive tobacco prevention education and instituting tobacco-free policies on all school grounds and events.

The objective of this study was to evaluate the effectiveness of school-level tobacco-control policies using most recent data to understand if the existence of tobacco-free policies and tobacco-risk education in these schools influenced cigarette and e-cigarette use among middle and high school students. More specifically, this study (1) examined the prevalence of cigarette and e-cigarette use by tobacco-free education and policy status in Georgia middle and high schools and (2) estimated how tobacco-risk education and school tobacco-free policy impacted youth cigarette and e-cigarette use. Results of this study can be of importance to policymakers, tobacco-control advocates, public health professionals, and school administrators as they consider more effective policies and programs to prevent tobacco use and/or promote cessation.

¹Whether e-cigarettes are less harmful than regular or conventional cigarettes is a topic of debate and more research is needed (Brown, Beard, Kotz, Michie, & West, 2014; Schober et al., 2014). Further, there is inconclusive and limited evidence suggesting that e-cigarettes may be beneficial for quitting (Caraballo, Shafer, Patel, Davis, & McAfee, 2017; Centers for Disease Control and Prevention (CDC), 2017; Lucchiari et al., 2016).

METHODS

Institutional review board approval

Ethical approval for this research was obtained by the Augusta University Institutional Review Board (Decision No. 1109160-1).

Participants and setting

This study used de-identified individual-level data from the 2013 and 2015 Georgia Youth Tobacco Survey (GYTS), a school-based questionnaire from the National Youth Tobacco Survey, which is administered semiannually. GYTS is a cross-sectional, state-representative sample based on a probability sample design. Data were statistically weighted to represent state-level estimates using the study-sampling frame from the U.S. Department of Education. A random sample of public middle (grades 6-8, year 2013) and high school (grades 9-12, years 2013 and 2015) students were selected to participate in this study and parental consent was obtained prior to administration of the survey. The questionnaire was comprised of questions pertaining to respondent demographics, cigarette smoking, use of other tobacco products, smoking advertising, smoking cessation, second-hand smoke, school policies, risk behavior, and attitudes related to tobacco. Data for this study were obtained through a data request to the Georgia Department of Public Health. The total sample available for analyses included 5,285 students, representing students from

the 2013 middle school (MS13) cohort (n=2,099), 2013 high school (HS13) cohort (n=1,775), and 2015 high school (HS15) cohort (n=1,411). Georgia did not survey middle schools in 2015.

Assessments and Measures

Outcome Measures

In this study, the outcome measures of interest were the use of cigarettes and e-cigarettes. Students were asked about the frequency of cigarette and e-cigarette use during the past 30 days (0, 1-2, 3-5, 6-9, 10-19, 20-29, and all 30 days). We recoded these answers into non-users (0 days) and current users (1-30 days).

Explanatory variables

There were two key explanatory variables of interest in this study. First, the existence of tobacco-free policy in schools was measured by asking students if their school had a tobacco-free policy. Second, student tobacco-risk education class attendance was measured by asking if students were taught in any of the classes about why they should not use tobacco products.

The demographic characteristics included gender, age, race, ethnicity, and grade level (6-12). To measure student attitudes towards tobacco products, we constructed an attitude score by adding student responses to three questions, which asked students (1) if tobacco use should be allowed inside the home or (2) in their vehicles and (3) if breathing smoke from other people's cigarettes or tobacco products' was harmful to one's health. These three questions were recoded as Yes/No and aggregated to generate a score ranging between 0 and 3, where higher scores indicated a more negative attitude towards tobacco use.

Social norms and perceptions, tobacco-free experiences, and exposure to tobacco advertising are important determinants of smoking, especially for the youth. To account for social norms and smoking perceptions students were asked (yes/no): Does smoking cigarettes make young people look cool or fit in? Are all tobacco products dangerous? How likely is it that you would ever use or wear something –

such as a lighter, T-shirt, hat, or sunglasses – that has a tobacco company name or picture on it? and How many of your four friends smoke cigarettes?

To account for tobacco-free experiences at home and elsewhere, students were asked if during the past 12 months their parents or guardians have talked about not using any type of tobacco product and if they have been involved in any organized activities to keep people their age from using any form of tobacco product. Finally, to account for youth exposure to tobacco advertising, we constructed a tobacco advertising exposure score by using a series of questions, which asked students if they have seen ads for cigarettes and other tobacco products when using internet, reading newspapers or magazines, when going to a store or gas station, or while watching TV or going to movies. Each of these questions were measured on a 6-point scale (1=not exposed to the ads; 6=always being exposed to ads). We aggregated these answers to create a score for ad exposure, ranging from 0 to 18, where higher score indicated more intensive exposure to tobacco advertising.

Statistical Analyses

Data were analyzed using major demographic, tobacco use, and tobacco experience related factors (Table 1). Prevalence of cigarette and e-cigarette use was analyzed for each cohort of students (2013 middle school, 2013 and 2015 high schools) and the combined sample by major demographic characteristics (gender, grade, race, and ethnicity) (Table 2). Additionally, the prevalence of cigarette and e-cigarette use was evaluated by school tobacco-free policy and tobacco-risk education status and tested for their statistical significance (Table 3).

Finally, we estimated multivariate logistic regression models (Table 4) where we examined the associations between cigarette and e-cigarette use status and factors likely to affect student's tobacco use, such as their demographic characteristics, tobacco-free experiences at home and elsewhere, perceptions and attitudes towards smoking, and existence of tobacco-free policy and tobacco risk education at the school. All statistical analyses were performed using Stata 14 (StataCorp. 2015).

TABLE 1
Sample Descriptive Statistics; 2013 & 2015 Georgia Youth Tobacco Survey, frequency (%)[§]

Characteristics	Total Sample	M.S. 2013	H.S. 2013	H.S. 2015*
<i>Gender</i>				
Male	2,635 (49.9%)	1,052 (50.1%)	882 (46.7%)	710 (50.3%)
Female	2,650 (50.1%)	1,047 (49.9%)	893 (50.3%)	701 (49.7%)
<i>Grade</i>				
6 th	632 (12.0%)	632 (30.3%)		
7 th	698 (13.3%)	698 (33.5%)		
8 th	756 (14.4%)	756 (36.2%)		
9 th	832 (15.8%)		472 (26.7%)	360 (25.6%)
10 th	770 (14.6%)		426 (24.1%)	344 (24.4%)
11 th	764 (14.5%)		386 (21.8%)	378 (26.9%)
12 th	810 (15.4%)		484 (27.4%)	326 (23.2%)
<i>Race/Ethnicity</i>				
Hispanic	715 (13.6%)	302 (14.5%)	214 (12.1%)	199 (14.0%)
White	2,371 (46.1%)	966 (47.2%)	879 (51.1%)	526 (38.2%)
African-American	1,975 (38.4%)	733 (35.8%)	590 (34.3%)	652 (47.4%)
Mixed	409 (8.0%)	181 (8.8%)	125 (7.3%)	103 (7.5%)
Other	390 (7.6%)	168 (8.2%)	127 (7.4%)	95 (6.9%)
<i>School Tobacco Policies/Education</i>				
Does your school have a tobacco-free policy?	3,494 (69.2%)	1,425 (72.0%)	1,236 (71.6%)	833 (61.8%)
Any classes at school teach tobacco risk education?	2,293 (45.1%)	1,136 (56.8%)	656 (37.8%)	501 (37.2%)
<i>Tobacco-Free Experiences at Home and Community</i>				
Last 12 months, parent talk about not using tobacco?	2,041 (38.4%)	869 (43.2%)	659 (37.9%)	513 (38.3%)
Last 12 months, organized events against tobacco?	742 (14.7%)	346 (17.3%)	222 (12.8%)	174 (13.1%)
<i>Smoking Attitudes/ Perceptions</i>				
Allow smoking inside home	821 (16.1%)	293 (14.5%)	331 (18.9%)	197 (5.0%)
Allow smoking inside vehicle	1,033 (20.4%)	339 (16.8%)	461 (26.6%)	233 (17.8%)
Breathing other's smoke is harmful	4,596 (90.3%)	1,868 (92.2%)	1,569 (90.1%)	1,392 (87.9%)
Smoking makes "look cool or fit in"	702 (13.8%)	259 (12.8%)	266 (15.3%)	177 (13.4%)
Agree that "tobacco products are dangerous"	4,397 (86.0%)	1,765 (87.4%)	1,525 (87.5%)	1,107 (81.9%)
<i>Total</i>	5,285	2,099	1,775	1,411

[§] Percentages may not sum-up to 100 due to rounding.

* Georgia did not survey middle schools for the 2015 Georgia Youth Tobacco Survey.

RESULTS

Sample Characteristics

Since middle and high school students represent distinct youth groups that have varying smoking and health behaviors, in this study we opted to report school-specific descriptive statistics along with the findings from the whole sample (Table 1). The sample consisted of almost equally represented male and female students who were primarily White (46%) or African American (38%); about 12-14% were of Hispanic ethnicity. Students in middle and high school grades were almost equally represented.

Asked if their school has a tobacco-free policy, about 69% of students reported were studying in a tobacco-free school and 45% indicated they have taken classes where they were taught about why they should not use tobacco products (57% among middle school students, 37% among high school students). Students also indicated that their parents spoke to them about not using tobacco (38% overall; 43% in MS13; 38% in HS13; 38% in HS15) and participated in organized anti-tobacco events (15% overall; 17% in MS13; 13% in HS13; 13% in HS15).

Smoking attitudes and perceptions are important factors that shape youth health behaviors and habits. A large portion of the students showed negative perceptions and attitudes towards smoking. For example, the vast majority of students indicated that smoking should not be allowed inside of the home (84%) or car (80%), and such sentiment has increased among high school students from 2013 to 2015. Further, students predominantly believed that secondhand smoke is harmful (90%) and tobacco products are dangerous (86%), which was equally echoed by students in different cohorts. Finally, 86% of students did not believe that smoking makes them “look cool or fit in,” which was slightly higher among middle school students (87% in MS13; 85% in HS13; 87% in HS15).

Prevalence of Smoking

Overall, 8.4% and 9.5% of the students were current users of cigarettes and e-cigarettes, respectively (Table 2). However, middle school students reported considerably lower smoking rates (4.3% e-cigarettes and 3.7% cigarettes) than high school students (HS13: 8.7% e-cigarettes and 13.2% cigarettes; HS15: 18.1% e-cigarettes and 9.2% cigarettes). Consistent increase in smoking rates were observed in the overall and cohort-specific samples as students progressed to higher grades. Among middle school students, more students used e-cigarettes (4.3%) compared to cigarettes (3.7%). Data on smoking from high school students exhibited an interesting dynamic. In 2013, more high school students smoked cigarettes (13.2%) than e-cigarettes (8.7%). However, these trends reversed two years later and the use of e-cigarettes increased considerably

to 18.1% while the use of cigarettes decreased to 9.2% among high school students in 2015.

Results also reveal that male students smoked at considerably higher rates than female students. Among males, 11.6% used e-cigarettes and 10.1% smoked cigarettes, whereas 7.3% of females used e-cigarettes and 6.6% smoked cigarettes. This gender gap was more evident among high school students. White students, compared to students from other non-mixed racial backgrounds, used both e-cigarettes (9.9%) and cigarettes (11.4%) at higher rates. However, students who reported being mixed race smoked at higher rates (10.5 and 8.6% respectively) and students of Hispanic ethnicity smoked at relatively higher rates as well (9.4 and 9.5%, respectively).

Tobacco Control Policies and Smoking

Table 3 reports results from evaluation of cigarette and e-cigarette use by school tobacco-free policy status and tobacco-risk education exposure.

Tobacco-free policy and smoking

In the overall sample, the difference in cigarette smoking rates between schools with and without tobacco-free policy were not statistically significant ($p=0.605$) and a similar conclusion was reached when looking at the individual cohorts. Our analyses showed that students used e-cigarettes at statistically higher rates in schools with tobacco-free policies (12.1%) compared to the schools without a policy (8.5%). However, when looking at the individual cohorts, results indicate the complete opposite; e-cigarette use was statistically lower in 2013 middle (3.3%) and high school (7.4%) cohorts where tobacco-free policy was present and there was no statistical difference in the 2015 high school student e-cigarette use rates (19.2%).

Tobacco-risk education and smoking

Results indicate that, overall, students smoked cigarettes (7.4% vs. 10%; $p<0.01$) and e-cigarettes (7.3% vs. 11.6%; $p<0.01$) at statistically lower rates in the schools that included tobacco-risk education classes. However, these results were not consistent in all individual cohorts. More specifically, statistically lower smoking rates for both cigarettes (2.8% vs. 5.2%; $p<0.01$) and e-cigarettes (2.9% vs. 5.8%; $p<0.01$) were reported by the middle school students who attended tobacco-risk education classes. However, statistically different rates were reported only for e-cigarettes (14.3% vs. 21.9%; $p<0.01$) by the 2015 high school students who attended such classes.

TABLE 2

Prevalence of Cigarette and e-Cigarette Use by Select Demographics, GYTS, 2013 and 2015

Characteristics	N [§]	E-cigarette users (%)	Cigarette users (%)
<i>Total Sample</i>			
Overall	5,310	9.5	8.4
Male	2,635	11.6	10.1
Female	2,650	7.3	6.6
6 th grade	632	3.3	2.1
7 th grade	698	4.2	2.2
8 th grade	756	4.9	6.2
9 th grade	832	9.9	8.2
10 th grade	770	13.4	9.2
11 th grade	764	13.6	10.3
12 th grade	810	15.2	17.8
Hispanic	715	9.4	9.5
White	2,371	9.9	11.4
African-American	1,975	8.9	5.0
Mixed	409	10.5	8.6
Other Race	390	9.2	7.2
<i>Middle School (2013)</i>			
Overall	2,099	4.3	3.7
Male	1,052	5.4	4.1
Female	1,047	3.2	3.3
6 th grade	632	3.3	2.1
7 th grade	698	4.2	2.2
8 th grade	756	4.9	6.2
Hispanic	302	4.6	5.3
White	966	3.6	4.1
African-American	733	4.4	2.6
Mixed	181	6.6	5.5
Other Race	168	6.0	4.2
<i>High School (2013)</i>			
Overall	1,775	8.7	13.2
Male	882	10.9	15.9
Female	893	6.4	10.6
9 th grade	472	6.6	10.6
10 th grade	426	9.6	11.0
11 th grade	386	8.0	11.4
12 th grade	484	10.3	19.0
Hispanic	214	7.9	15.4
White	879	9.9	18.5
African-American	590	6.8	7.1
Mixed	125	10.4	10.4
Other Race	127	7.9	8.7
<i>High School (2015)</i>			
Overall	1,434	18.1	9.2
Male	701	21.8	11.8
Female	710	14.4	6.5
9 th grade	360	14.2	5.0
10 th grade	344	18.0	7.0
11 th grade	378	19.3	9.3
12 th grade	326	22.4	15.6
Hispanic	199	18.1	9.6
White	526	21.5	12.7
African-American	652	15.8	5.8
Mixed	103	17.5	11.7
Other Race	95	16.8	10.5

Note. [§] Category numbers may not sum-up to the totals due to missing responses.

TABLE 3

Tobacco Use by School tobacco-Free Policy and Tobacco Risk Education Status, 2013 and 2015

	Overall			2013 Middle School			2013 High School			2015 High School		
	n ^a	% ^b	p ^c	n	%	p	n	%	p	n	%	p
E-cigarettes												
Tobacco-free policy	3,437	12.1	0.000	1,408	3.3	0.007	1,223	7.4	0.006	806	19.2	0.931
No tobacco-free policy	1,527	8.5		546	6.0		482	11.6		499	19.0	
Tobacco risk education	2,260	7.3	0.000	1,124	2.9	0.002	648	9.4	0.446	488	14.3	0.001
No tobacco risk education	2,738	11.6		850	5.8		1,067	8.3		821	21.9	
Cigarettes												
Tobacco-free policy	3,401	8.6	0.605	1,393	3.6	0.567	1,198	13.8	0.810	810	9.4	0.603
No tobacco-free policy	1,476	9.0		531	4.1		458	13.3		487	10.3	
Tobacco risk education	2,227	7.4	0.001	1,112	2.8	0.007	630	13.7	0.801	485	9.7	0.949
No tobacco risk education	2,681	10.0		831	5.2		1,036	14.1		814	9.6	

Notes. (a) represents the number of responses in the specific category, (b) is the percent of respondents who currently smoke, and (c) is the p-value of the Chi-squared test for statistical difference in e-cigarette and traditional cigarette use status by tobacco-free policy and tobacco-risk education status. Numbers may not sum-up to the totals from Table 1 due to missing responses. For example, 3,437 students indicated that their school has a tobacco-free policy and of these students 12.1% currently consume e-cigarettes. The Chi-squared test (p-value=0.000) indicates that there is a statistical difference in the number of current e-cigarette users in schools with tobacco-free policy compared to the schools without such policy.

Multivariate Determinants of Cigarette and e-Cigarette Use among Youth

Table 4 reports results from multivariate logistic regressions. In these models, our binary dependent variables were whether or not students currently used cigarettes or e-cigarettes. The overall objective of these models was to estimate if existence of tobacco-free policies and school based tobacco-risk education influenced cigarette and e-cigarette use among middle and high school students, while controlling for demographic characteristics of the students, tobacco-free experiences at home and community, attitudes and perceptions towards smoking, and current use of other tobacco products. Results indicate that cigarette use was 55% higher (OR=1.55; $p<0.05$) in schools that adopted tobacco-free policies. Interestingly, cigarette smoking rates were statistically similar among middle school students irrespective of school's tobacco-free status, but were statistically higher (OR=1.56; $p<0.05$) among high school students. Our results also indicated that tobacco-free policies had no effect on e-cigarette use among middle or high school students or the whole sample.

Exposure to the tobacco-risk education was not statistically associated with lower or higher odds of smoking in our sample, but the combination of tobacco-free policy and teaching of tobacco risks was statistically associated with approximately 50% lower odds of cigarette smoking (OR=0.53; $p<0.05$) in our combined sample.

We also found that use of either cigarettes or e-cigarettes was statistically significantly associated with the use of the other by at least 2.6 times ($p<0.05$) in all cohort models. Use of 'other tobacco products' (i.e. other than cigarettes or e-cigarettes) was also significantly associated with 10-31% higher odds ($p<0.05$) of using cigarettes or e-cigarettes in all

cohort models. These findings suggest that significant dual use patterns exist among youth.

DISCUSSION

Our study examined the impact of school-based tobacco-risk education and tobacco-free policies on youth tobacco use in Georgia middle schools and high schools using data from the 2013 and 2015 Georgia Youth Tobacco Survey.

Between 2013 and 2015, the use of conventional cigarettes among Georgia high school students has decreased, however the use of e-cigarettes has increased considerably; a similar trend was evident in an earlier finding by Hawkins et al. (2018). These findings echo the alarming reports in the recent literature of the rise of e-cigarettes in popularity and its consequence on health and as a possible gateway to smoking cigarettes in the future. The rise in e-cigarette use among youth could be an attempt to use it as a more socially acceptable or even perceivably less harmful alternative to conventional tobacco products (Centers for Disease Control and Prevention, 2015a, 2015b, 2019). Adolescents have a perceived notion that e-cigarettes have lower health risk and are more suitable smoking alternative to traditional cigarettes (Wills, Knight, Williams, Pagano, & Sargent, 2015). Research has shown that electronic cigarettes may not be harmless as their vapor contained toxins such as carbonyl compounds, volatile organic compounds, and nitrosamines at lower levels than combustible cigarettes (Goniewicz et al., 2014). Other research has shown that nicotine alone may have deleterious effects on the developing brain (Dwyer, McQuown, & Leslie, 2009). We also saw that cigarette and e-cigarette use increased with age, similar to the earlier findings (Hawkins et al., 2018). Males, students of mixed and White races as well as

TABLE 4

Determinants of Smoking among Youth, Odds Ratios (OR) from Multivariate Logistic Regression

Variables	Cigarettes			E-Cigarettes		
	Total Sample	Middle School	High School	Total Sample	Middle School	High School
Male (ref. female)	0.946	0.931	0.917	1.054	1.085	1.071
School level (ref. 2013 middle school)						
2013 High School	2.813***			1.356		
2015 High School	2.027***			6.628***		
Race (ref. White)						
African American	0.488***	0.836	0.409***	0.816	1.022	0.942
Mixed	0.792	1.005	0.692	1.029	2.190*	0.914
Other	0.609*	0.814	0.578*	0.605*	0.973	0.700
Hispanic ethnicity (ref. not Hispanic)	1.435*	2.768**	1.105	0.898	0.681	1.025
Tobacco-free policy (ref. no policy)	1.548**	1.636	1.561**	1.105	0.616	1.006
Tobacco risk education (ref. none)	1.228	1.084	1.312	0.750	1.113	0.652
Schools with policy <u>and</u> risk education	0.534**	0.434	0.554	0.868	0.704	1.022
Smoking Attitudes	0.569***	0.488***	0.587***	0.673***	0.463***	0.770***
Smoking makes “look cool or fit in”	1.438**	1.106	1.547**	1.607***	0.969	1.674***
Tobacco products are dangerous	0.980	1.111	0.970	0.675**	1.034	0.552***
Parent talked about not using tobacco	1.660***	1.473	1.703***	0.970	1.179	0.961
Organized events against tobacco use	0.925	1.088	0.878	0.892	1.298	0.803
Number of friends smoking (ref. none)						
1-2 friends	6.283***	9.328***	5.864***	2.052***	4.015***	1.462**
3-4 friends	16.017***	16.330***	16.788***	1.921***	5.009***	1.507*
Exposure to tobacco advertising	0.965*	1.011	0.956*	1.033*	1.000	1.023
Likely to wear tobacco apparel	1.365**	1.841*	1.303	1.485***	2.323***	1.304*
Use of another tobacco products						
Current e-cigarette user	3.058***	2.695**	2.776***			
Current Other Tobacco user	1.216***	1.102**	1.277***	1.263***		1.312***
Current cigarette user				3.153***	3.666***	2.747***
Constant	0.030***	0.021***	0.078***	0.054***	0.082***	0.188***
N	4,526	1,814	2,709	4,526	1,816	2,701

Notes. The dependent variable in the models is the current use of cigarettes or e-cigarettes. In all equations, the dependent variable is binary (current user vs non-user). High school models include pooled data from 2013 and 2015 high school cohorts. Statistical significance levels are indicated using stars, where the notations are: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Hispanic students, compared to the others, smoked at much higher rates. Similar gender disparity was reported by Hawkins et al. (2018) using the YRBS data for the United States.

While our results showed some strong statistical associations between tobacco use and tobacco-risk education and tobacco-free policies in these schools, these associations were not consistent across all cohorts and samples, indicating that these policies have had mixed impact on student tobacco use. We found students who attended schools with tobacco-risk education smoked cigarettes and e-cigarettes at statistically lower rates than students whose schools did not have these programs. However, these results were not consistent in all individual cohorts (i.e. middle school, high school).

To support prevention and cessation efforts, future research should examine the strengths of tobacco-risk education curriculum and pedagogy, as we hypothesize that it may vary across schools, which was not captured in our data. For example, its effectiveness may vary depending upon who delivers the education. Research shows that peer-based or role-model (e.g. coach, athlete) based interventions have

higher effectiveness (Coley et al., 2013). Future research should also focus on examining factors (e.g. timing, intensity, content) and the ways of providing tobacco-risk education to youth that is more effective and has a lasting effect on preventing initiation and increasing cessation. It is essential to develop interventions and strategies that target youth not only in classrooms but also outside of schools, thus prolonging the exposure to such messages.

In the multivariate analysis, the impact of tobacco-free policy on youth's use of cigarettes was statistically significant and indicated that students in the schools with tobacco-free policy smoked more cigarettes. This finding is counterintuitive since one would expect schools with tobacco-free policy to have lower smoking rates. We assume this may be the result of tobacco-free policies being adopted by schools where tobacco use is of significant concern, hence, higher smoking rates. It is also important to note that student perception about the existence of such policies might not reveal the actual existence of these policies. Further, we believe that the effectiveness of the policy will largely depend on the length of existence of these policies and the strength of enforcement. The latter is likely to directly determine the compliance with policy and,

hence, behavior change among students. Future research should examine the relationship between tobacco use outcomes and the length tobacco-free policies are in effect. We believe that tobacco use will be lower at schools with a longer history of such policies. Finally, future research should examine the effects of such policies on tobacco use outcomes in a longitudinal context to measure the dynamic effect of these policies.

Our results also showed strong association between dual use of cigarettes and e-cigarettes as well as other tobacco products, which confirms earlier findings in the literature that a large portion of e-cigarette users combine cigarettes and other tobacco products (Wills et al., 2015). Smoking behavior among adolescents is associated with availability of the product, affordability, accessibility, restrictive policies, parental influences, peer pressure, and simple curiosity of experimentation. We found that students with better attitudes and perceptions towards tobacco products were less likely to use tobacco products. Future studies may examine how these attitudes and perceptions shape youth behavior and use this knowledge to develop and deploy more effective interventions.

There are few limitations to this study. This study uses self-reported data, which may result in inaccurate inferences since youth (and respondents in general) tend to underreport negative or unhealthy behaviors such as smoking. Also, when reporting the school's tobacco-free policy status, some students might not have had a proper knowledge of it.

CONCLUSIONS

Smoking among youth is a major public health issue, as about 90% of smoking initiation starts by age 18 and 99% by age 26. Youth smoking is also associated with alcohol and drug use, which in turn increases risks of traffic fatalities and violent crimes as well as may affect academic performance of these young individuals. Policies and programs designed to prevent tobacco use and promote cessation are critical in nudging youth towards healthy behaviors and lifestyle.

We estimated the associations between school-level tobacco-risk education and tobacco-free policy and youth cigarette and e-cigarette use. Results showed that between 2013 and 2015, the use of conventional cigarettes among Georgia high school students has decreased, however the use of e-cigarettes has increased considerably. We saw some strong statistical associations between tobacco-use behavior and tobacco-risk education and tobacco-free policy in these schools, however, these associations were not consistent across all grades. The association of tobacco-free policy and youth use of cigarettes was positive and significant, which is counterintuitive and may be the result of adoption of tobacco-free policy by the schools where tobacco use is of a significant concern.

Results of this study may be of importance to policymakers, tobacco-control advocates, public health professionals, and school administrators as they consider more effective policies and programs to prevent tobacco use and/or promote cessation. Future research should examine the effects of these policies, their enforcement, and length of existence in detail to provide more evidence into the effectiveness of these policies.

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