

# Associations between Appalachian youth tobacco consumption and communication channel use

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## ABSTRACT

**INTRODUCTION** Youth tobacco use rates in Appalachia exceed the US national average, and e-cigarette use has increased. Thus, further research is needed to understand how these youth receive and share product information.

**METHODS** Middle and high school students in rural Appalachia were surveyed (N=1103). The primary outcome, tobacco use, was categorized as: never users, cigarette-only users, smokeless-only users, e-cigarette-only users, and polytobacco users. Associations between receiving or sharing conventional tobacco-related or e-cigarette-related information via specific communication channels and tobacco use were assessed.

**RESULTS** Participants who received tobacco information from friends and family (FF) (OR=1.87; 95% CI: 1.35–2.57), public displays (PUB) (OR=1.49; 95% CI: 1.09–2.05), and digital media (DIG) (OR=1.95; 95% CI: 1.41–2.70) and e-cigarette information via the same communication channels, FF (OR=2.65; 95% CI: 1.93–3.65), PUB (OR=1.62; 95% CI: 1.17–2.26), and DIG (OR=2.24; 95% CI: 1.61–3.12), had greater odds of being polytobacco users, compared to never users. Participants who received e-cigarette-related information from FF (OR=2.42; 95% CI: 1.42–4.13) and PUB (OR=2.13; 95% CI: 1.25–3.65) had greater odds of being e-cigarette-only users compared to never users. Participants who shared e-cigarette-related information with FF had greater odds of being e-cigarette-only users (OR=3.16; 95% CI: 1.80–5.58) and polytobacco users (OR=4.48; 95% CI: 3.16–6.35) compared to never users.

**CONCLUSIONS** Receiving and sharing tobacco-related and e-cigarette-related information via multiple communication channels is associated with e-cigarette and polytobacco use among Appalachian youth. Several channels may need to be utilized in health campaigns to influence youth.

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## INTRODUCTION

Tobacco use remains the leading cause of preventable death worldwide and cigarette smoking alone kills approximately half a million people in the US every year<sup>1</sup>. Public health concerns have increased with the emergence of e-cigarettes, especially given that youth who experiment with e-cigarettes are more likely to be users of other tobacco products<sup>2,3</sup>. Additionally, e-cigarette use by youth has been linked

to nicotine dependence, regardless of whether other tobacco products are used<sup>4</sup>. Research suggests that experimentation at a young age is associated with remaining a smoker, and possibly becoming a heavy smoker, after transitioning to adulthood<sup>5</sup>. Because youth tobacco use may lead to future tobacco consumption addiction, research examining early-stage tobacco experiences is imperative in preventing tobacco-related morbidity and mortality<sup>1,5</sup>.

Several factors influence youth experimentation with and continued use of tobacco products, and decreases in use in some areas have been offset by increases in others. Whereas cigarette use among youth decreased in recent years, the use of flavored tobacco and e-cigarettes has increased<sup>6-8</sup>. In 2018, about 4.9 million middle and high school students in the US used some form of tobacco during the past month<sup>7</sup>. Additionally, 2.4% of middle school students and 11.3% of high school students reported current use of two or more tobacco products, with youth polytobacco users at higher risk for continued use into adulthood<sup>1,6,7</sup>. Further, several studies have found associations between flavored products and polytobacco use<sup>9-11</sup>. Also, among the multiple factors that encourage youth to initiate tobacco product consumption, or continue use, are exposure to tobacco advertising, media promotion, and perceptions of smoking acceptance<sup>12-14</sup>; and some research has found associations between adolescent exposure to tobacco marketing and multiple tobacco product or polytobacco use<sup>15</sup>. With the continued influx of new tobacco products and different options for communicating, it is important to understand where and how youth receive information about new marketplace options, i.e. the channels used to communicate tobacco-related information.

Youth are exposed to an array of communication channels from which they may learn about tobacco products. Since the early 1900s, tobacco companies have advertised their products to promote tobacco initiation and use, and youth-targeted tobacco advertising has been found to influence youth smoking<sup>16-18</sup>. Today, tobacco companies market tobacco products, including e-cigarettes, in ways that are appealing to youth through platforms such as digital and social media<sup>19,20</sup>. Between 2014 and 2016, youth exposure to e-cigarette advertisements increased each year (68.9%, 73.0% and 78.2%, respectively)<sup>21</sup>. For 2016, youth reported the greatest exposure in retail stores (68.0%), with additional exposures via the internet (40.6%), television (37.7%), and print media (23.9%)<sup>21</sup>. Given increasing interest in the impact of e-cigarette advertising on subsequent use and evidence suggesting that exposure to e-cigarette advertisements may impact perceptions not only of e-cigarettes but also of combustible

tobacco products, additional study in these areas is needed<sup>22,23</sup>. As with the relationship between conventional tobacco advertising and youth tobacco use, studies have found positive associations between youth exposure to e-cigarette advertising or marketing and current use of or intent to use e-cigarettes<sup>23-28</sup>. For example, an analysis of data from the 2014 National Youth Tobacco Survey (NYTS) found that increased exposure to e-cigarette advertising resulted in higher likelihood of ever and current use of e-cigarettes<sup>27</sup>. More specifically, exposure to internet, print, retail and TV/movie e-cigarette marketing was linked with youth e-cigarette use as well as non-user susceptibility to use<sup>27</sup>. Key differences exist across communication channels. For example, print media and broadcast messages are typically designed for large, general audiences and may be subject to voluntary or government restrictions. In contrast, the digital media landscape is quickly transforming and offers increasing options for tailored messaging for specific audiences, often with little or no oversight. Digital media platforms, many of which are popular with youth, provide opportunities for tobacco companies to circumvent years of tobacco control efforts<sup>20</sup>.

In addition, some research has examined communication channels for sharing tobacco-related information. For example, one study found that youth learned about e-cigarettes from media, friends and family, and the school environment<sup>29</sup>, and another reported that digital media and friends and family were key sources of e-cigarette information<sup>30</sup>. Also, one investigation concluded that youth who engage with tobacco-related information via social media were more likely to be susceptible to tobacco use (e-cigarettes, smoking)<sup>31</sup>. Further, some findings suggest that friends and family influence the potential for youth e-cigarette use<sup>32</sup> with nearly 40% of youth who had tried e-cigarettes indicating that a friend or family member was the reason why they tried these products<sup>32</sup>. However, careful consideration of the means by which youth receive and share conventional tobacco-related and e-cigarette-related information is needed. Additionally, inquiries examining especially vulnerable youth populations, such as Appalachian youth, are needed.

The present study focuses on Appalachia, a region

where many rural youth are vulnerable to tobacco use. As has been documented in several studies, individuals living in poverty are more likely to use tobacco than those living above the poverty level<sup>33</sup>, and poverty rates in Appalachia continue to exceed the US national average. Recent estimates indicate a poverty rate of 16.3% in the Appalachian region compared to a national poverty rate of 14.6%<sup>34</sup>. Concomitantly, tobacco use is high in Appalachia – the smoking rate in the Appalachian region (19.8%) exceeds the US national average of 16.3%, and the 16.0% average in areas outside Appalachia<sup>35,36</sup>, which means that youth are more often exposed to tobacco products. Further, despite overall reductions in cigarette smoking by youth, decreases have been lower in rural areas than urban ones, and, even after controlling for socioeconomic status, the rural–urban gap has widened<sup>37</sup>. In fact, several Appalachian states have youth tobacco use rates that exceed the national average, and some areas are among the highest<sup>38,39</sup>. A variety of reasons, from familial and cultural acceptance to regional histories of growing and economic dependence on tobacco, contribute to the greater prevalence of tobacco use in many Appalachian communities<sup>40–42</sup>. Influences linked to family members, rural life and tobacco’s pervasiveness have been reported to shape youth tobacco use in the region<sup>40,41,43–47</sup>. Across studies, close Appalachian families and their acceptance of tobacco use in homes, in some cases allowing youth to first experiment with tobacco products there, have been discussed as making tobacco use more likely<sup>40,41</sup>. Additionally, beyond the family unit, youth in these rural areas often have access to places to use tobacco (e.g. in nature), experience considerable freedom from adult supervision, know community members willing to assist them with procuring tobacco products, and report boredom from a shortage of structured recreational activities, all of which may contribute to using tobacco<sup>41</sup>. Thus, Appalachian youth are at higher risk for tobacco use and tobacco-related diseases than the general population.

A better understanding of the channels through which youth receive information on existing and emerging tobacco products may be useful in targeting anti-tobacco campaigns to prevent youth experimentation and deter continued use. Although the association between receiving tobacco-related

information and tobacco use in youth has been previously documented<sup>23,25–28,48–51</sup>, the communication channels rural youth, especially those living in the Appalachian region, use to receive or share tobacco-related information, and associations between tobacco use and these channels, remain underexamined. Several factors may shape the communication channels by which Appalachian youth receive or share tobacco-related information. For example, as mentioned above, several studies have documented strong family and community ties for youth in the region<sup>40–42</sup>. Additionally, compared to other areas, tobacco use is widely accepted by peers and families in the region<sup>37</sup>, and tobacco use is often allowed in homes. Thus, friends and family members may play especially important roles in exchanging tobacco-related information for youth living in this area. Research has also shown that digital communication has increased in the region, with many Appalachian youth using social media to obtain information from the internet<sup>52</sup>. Furthermore, studies have found that areas with greater poverty<sup>53</sup> as well as those that are not metropolitan<sup>54</sup> are more likely to experience point-of-sale tobacco marketing, where youth see more advertisements and/or products displayed in local places, ranging from gas stations to grocery stores. Based on these findings, channels such as digital media and public displays may be important for Appalachian youth. But, at present, little is known regarding the communication channels that these rural youth employ to receive or share tobacco-related information.

This study examined the relationship between receiving and sharing tobacco-related information via six communication channels [friends and family (FF); youth, school, and community groups (YSCG); broadcast media (BRO); print media (PRI); public displays (PUB); and digital media (DIG)] and tobacco use (i.e. cigarette only, smokeless only, e-cigarette only, and polytobacco) among Appalachian youth. The study’s specific aims were: 1) to investigate the distribution of communication channels through which Appalachian youth receive and share tobacco-related information by tobacco use status, and 2) to evaluate the associations between receiving and sharing tobacco-related information via these communication channels on tobacco use among Appalachian youth.

## METHODS

### Study design

The Youth Appalachian Tobacco Study (YATS) was conducted from fall 2014 to spring 2016. Questionnaires were distributed to middle and high school students in the Appalachian regions of Kentucky, North Carolina, and New York. Before data collection, parents were provided with a letter describing the study and the ability to decline their child's participation. Students were given assent forms and could decline participation as well. The questionnaire contained items addressing sociodemographic information, perceptions of tobacco products, tobacco communication, tobacco marketing and advertising, tobacco harms, as well as tobacco use patterns. Participants completed the questionnaire during the school day and the questionnaire took approximately 40 minutes to complete. Approval of the University of Louisville Institutional Review Board was obtained for this research.

### Participants

A total of 1280 students participated in YATS. This analysis examined participants who exclusively used conventional tobacco products or e-cigarettes, used multiple tobacco products, or had not used a tobacco product. Thus, participants missing tobacco use information ( $n=94$ ) were excluded. Missing responses for whether participants received or shared tobacco-related information via the six communication channels ( $n=65$ ) were also excluded. Because gender was considered a potential confounder of the primary exposure-outcome relationship, participants with missing information on gender were excluded ( $n=18$ ). The final analytic sample consisted of 1103 participants.

### Measures

Sociodemographic characteristics including gender, race/ethnicity, age, school type and school state (location) were evaluated. Participants identified as either male or female. Race/ethnicity included White/Caucasian, Black/African American, Hispanic, Asian, other, and two or more, and was dichotomized into White/Caucasian and Non-White/Non-Caucasian. Age was treated as a continuous variable. School type was dichotomized as middle or high school, and school state included three locations: Kentucky, North Carolina, and New York. Tobacco use status was determined by participants' responses to questions

about their ever (lifetime) and current (past 30-day) cigarette, smokeless tobacco (e.g. products, such as chewing tobacco or snuff, that are not combusted or burned), and e-cigarette use. Participants who identified as exclusive ever or current cigarette users were classified as cigarette-only users, and the same applied to participants who identified as exclusive ever or current smokeless tobacco users (smokeless-only users) and participants who identified as exclusive ever or current e-cigarette users (e-cigarette-only users). Participants who identified as ever or current users of two or more products were categorized as polytobacco users. Never users were categorized as participants who had never used cigarettes, smokeless tobacco, or e-cigarettes.

Participants specified whether they received or shared tobacco-related information through communication channels on a 5-point scale (1=strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree). Agreement statements were dichotomized (i.e. disagree, responses 1–3; agree, responses 4–5). A total of six communication channels were included. Participants indicated whether they agreed that they received tobacco-related information from: 1) 'talking with people I know, such as friends and family' (FF); 2) 'programs in which I participate, such as youth, school or community groups' (YSCG); 3) 'broadcast media like television and radio' (BRO); 4) 'print media like pamphlets, flyers, and posters' (PRI); 5) 'public displays, such as billboards' (PUB); and 6) 'digital media like blogs or social media' (DIG). Participants also responded regarding e-cigarette-related information via the same six channels. Additionally, participants indicated whether they shared tobacco-related information with FF and whether they shared e-cigarette-related information with FF.

### Statistical analysis

Five tobacco use categories were examined: never users, cigarette-only users, smokeless-only users, e-cigarette-only users, and polytobacco users. Demographic characteristics were presented as frequencies and percentages for categorical variables and means (SD) and medians (min-max) of continuous variables by tobacco use status. Chi-squared tests of independence for categorical variables and analysis

of variance (ANOVA) tests for continuous variables were computed to compare differences among the five tobacco use groups. Additional comparisons between never users and ever users (i.e. ever tobacco users of any product) were analyzed by demographic characteristics using chi-squared tests and Student's t-test, as appropriate.

Chi-squared tests were used to generate p-values comparing all tobacco use groups, as well as between never users and ever users, by each communication channel. Multivariable multinomial logistic regression models evaluated associations between tobacco use status and each communication channel. Covariates with Wald p-values greater than 0.05 were excluded from the models; age and school type were highly correlated, thus only school type was included. Agreeing that tobacco-related information was received or shared via each communication

channel was the exposure, with disagreeing as the reference group, and tobacco use status was the outcome with never users as the reference group, after adjustment for gender, school type, and school state. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) are reported. Additionally, AORs for each relationship between tobacco use status and receiving and sharing tobacco-related information via FF were plotted to illustrate differences in effects. Data were analyzed using SAS 9.4 (Cary, N.C.).

**RESULTS**

**Participant characteristics**

Table 1 describes participant characteristics by tobacco use status. Of the 1103 participants, 723 (65.5%) were never users, 52 (4.7%) were cigarette-only users, 38 (3.4%) were smokeless-only users, 38 (3.4%) were smokeless-only users, 61

Table 1. Participant characteristics by tobacco use status (N=1103)

Characteristics	Total n (%)	Never n (%)	Cigarette n (%)	Smokeless n (%)	E-cigarette n (%)	Polytobacco n (%)	p
	1103 (100.0)	723 (65.5)	52 (4.7)	38 (3.4)	61 (5.5)	229 (20.8)	
<b>Gender</b>							<0.001 <sup>a</sup>
Male	561 (50.9)	354 (49.0)	20 (38.5)	30 (79.0)	27 (44.3)	130 (56.8)	0.082 <sup>b</sup>
Female	542 (49.1)	369 (51.0)	32 (61.5)	8 (21.0)	34 (55.7)	99 (43.2)	
<b>Race/Ethnicity</b>							0.64 <sup>a</sup>
White/Caucasian	947 (85.9)	618 (87.5)	43 (89.6)	35 (94.6)	53 (88.3)	198 (90.0)	0.21 <sup>b</sup>
Non-White/Non-Caucasian	124 (11.2)	88 (12.2)	5 (9.6)	2 (5.3)	7 (11.5)	22 (9.6)	
<b>Age (years)</b>							<0.001 <sup>a</sup>
Mean ± SD	13.8 ± 1.9	13.3 ± 1.8	14.3 ± 2.0	14.4 ± 2.2	14.1 ± 1.8	14.8 ± 1.8	<0.001 <sup>b</sup>
Median (min-max)	14 (11-19)	13 (11-19)	14 (11-19)	14 (11.5-19)	14 (11-18)	15 (11-19)	
<b>School type</b>							<0.001 <sup>a</sup>
Middle School	671 (60.8)	498 (68.9)	29 (55.8)	20 (52.6)	31 (50.8)	93 (40.6)	<0.001 <sup>b</sup>
High School	432 (39.2)	225 (31.1)	23 (44.2)	18 (47.4)	30 (49.2)	136 (59.4)	
<b>School state</b>							<0.001 <sup>a</sup>
Kentucky	389 (35.3)	214 (29.6)	22 (42.3)	22 (57.9)	19 (31.1)	112 (48.9)	<0.001 <sup>b</sup>
North Carolina	504 (45.7)	355 (49.1)	22 (42.3)	5 (13.2)	32 (52.5)	90 (39.3)	
New York	210 (19.0)	154 (21.3)	8 (15.4)	11 (28.9)	10 (16.4)	27 (11.8)	
<b>Cigarette use history<sup>c</sup></b>							-
Ever Users	160 (14.5)	-	41 (78.8)	-	-	119 (52.0)	-
Current Users	111 (10.1)	-	11 (21.2)	-	-	100 (43.7)	-
<b>Smokeless use history<sup>c</sup></b>							-
Ever Users	100 (9.1)	-	-	25 (65.8)	-	75 (32.8)	-
Current Users	96 (8.7)	-	-	13 (34.2)	-	83 (36.2)	-
<b>E-cigarette use history<sup>c</sup></b>							-
Ever Users	157 (14.2)	-	-	-	40 (65.6)	117 (51.1)	-
Current Users	104 (9.4)	-	-	-	21 (34.4)	83 (36.2)	-

a Chi-squared test or ANOVA test comparison across all tobacco use groups. b Chi-squared (categorical) or Student's t-test (continuous) p-values comparing never users to ever users by presented characteristics. c Total ever use equals the combined sum of ever use and current use. Missing values: Race/Ethnicity (n=32).

(5.5%) were e-cigarette-only users, and 229 (20.8%) were polytobacco users. The gender distribution of participants was about even (50.9% male, 49.1% female), and the majority of participants were White/Caucasian (85.9%). The age of participants ranged from 11–19 years (median: 14; mean: 13.8; SD: 1.9), and more participants were in middle school (60.8%) than high school (39.2%). The majority of participants attended school in North Carolina (45.7%), followed by Kentucky (35.3%) and New York (19.0%).

Nearly a fourth of the sample had ever used cigarettes (24.6%) and e-cigarettes (23.6%). Approximately a tenth identified as current users of cigarettes (10.1%), smokeless tobacco (8.7%), and e-cigarettes (9.4%). Gender, age, school type, and state significantly differed across tobacco use status ( $p < 0.001$  for each analysis). When comparing the distribution of never users to ever users, age, school type and state significantly differed ( $p < 0.001$  for each analysis), but not gender ( $p = 0.082$ ).

### Reported channels of receiving and sharing tobacco-related information

Table 2 shows distributions of receiving and sharing tobacco-related information via communication channels by tobacco use status. More than half of participants agreed that they receive conventional tobacco-related information from FF (51.1%) and BRO (53.0%). These results were consistent across cigarette-only users, e-cigarette-only users, and polytobacco users for FF (55.8%, 54.1%, and 63.8%, respectively), with smokeless-only users indicating slightly lower agreement for this channel (47.4%). The same trend occurred for BRO. Across all tobacco use groups, there were significant differences in three of the six communication channels: FF ( $p < 0.001$ ), PUB ( $p = 0.013$ ), and DIG ( $p < 0.001$ ). For comparisons between never users and ever users, FF ( $p < 0.001$ ) and DIG ( $p < 0.001$ ) significantly differed, but not PUB ( $p = 0.17$ ).

Fewer than half of participants receive e-cigarette-related information from each communication

Table 2. Reported channels of receiving and sharing tobacco-related information by tobacco use status (N=1103)

Communication channels	Total n (%)	Never n (%)	Cigarette n (%)	Smokeless n (%)	E-cigarette n (%)	Polytobacco n (%)	p
	1103 (100.0)	723 (65.5)	52 (4.7)	38 (3.4)	61 (5.5)	229 (20.8)	
<i>Receiving conventional tobacco-related information</i>							
<b>Friends and Family (FF)</b>							<0.001 <sup>a</sup>
Agree	564 (51.1)	338 (46.8)	29 (55.8)	18 (47.4)	33 (54.1)	146 (63.8)	<0.001 <sup>b</sup>
Disagree	539 (48.9)	385 (53.2)	23 (44.2)	20 (52.6)	28 (45.9)	83 (36.2)	
<b>YSCG<sup>c</sup></b>							0.48 <sup>a</sup>
Agree	508 (46.1)	346 (47.9)	22 (42.3)	14 (36.8)	28 (45.9)	98 (42.8)	0.10 <sup>b</sup>
Disagree	595 (53.9)	377 (52.1)	30 (57.7)	24 (63.2)	33 (54.1)	131 (57.2)	
<b>Broadcast Media (BRO)</b>							0.75 <sup>a</sup>
Agree	584 (53.0)	387 (53.5)	27 (51.9)	16 (42.1)	32 (52.5)	122 (53.3)	0.59 <sup>b</sup>
Disagree	519 (47.0)	336 (46.5)	25 (48.1)	22 (57.9)	29 (47.5)	107 (46.7)	
<b>Print Media (PRI)</b>							0.77 <sup>a</sup>
Agree	378 (34.3)	241 (33.3)	19 (36.5)	11 (29.0)	23 (37.7)	84 (36.7)	0.37 <sup>b</sup>
Disagree	725 (65.7)	482 (66.7)	33 (63.5)	27 (71.0)	38 (62.3)	145 (63.3)	
<b>Public Displays (PUB)</b>							0.013 <sup>a</sup>
Agree	488 (44.2)	309 (42.7)	22 (42.3)	9 (23.7)	31 (50.8)	117 (51.1)	0.17 <sup>b</sup>
Disagree	615 (55.8)	414 (57.3)	30 (57.7)	29 (76.3)	30 (49.2)	112 (48.9)	
<b>Digital Media (DIG)</b>							<0.001 <sup>a</sup>
Agree	431 (39.1)	254 (35.1)	25 (48.1)	11 (29.0)	23 (37.7)	118 (51.5)	<0.001 <sup>b</sup>
Disagree	672 (60.9)	469 (64.9)	27 (51.9)	27 (71.0)	38 (62.3)	111 (48.5)	

Continued

Table 2. Continued

Communication channels	Total n (%)	Never n (%)	Cigarette n (%)	Smokeless n (%)	E-cigarette n (%)	Polytobacco n (%)	p
<i>Receiving e-cigarette-related information</i>							
<b>Friends and Family (FF)</b>							<0.001 <sup>a</sup>
Agree	422 (38.3)	226 (31.3)	24 (46.2)	9 (23.7)	33 (54.1)	130 (56.8)	<0.001 <sup>b</sup>
Disagree	681 (61.7)	497 (68.7)	28 (53.8)	29 (76.3)	28 (45.9)	99 (43.2)	
<b>YSCG<sup>c</sup></b>							0.08 <sup>a</sup>
Agree	280 (25.4)	182 (25.2)	14 (26.9)	3 (7.9)	14 (23.0)	67 (29.3)	0.82 <sup>b</sup>
Disagree	823 (74.6)	541 (74.8)	38 (73.1)	35 (92.1)	47 (77.0)	162 (70.7)	
<b>Broadcast Media (BRO)</b>							0.007 <sup>a</sup>
Agree	484 (43.9)	315 (43.6)	21 (40.4)	7 (18.4)	26 (42.6)	115 (50.2)	0.77 <sup>b</sup>
Disagree	619 (56.1)	408 (56.4)	31 (59.6)	31 (81.6)	35 (57.4)	114 (49.8)	
<b>Print Media (PRI)</b>							0.035 <sup>a</sup>
Agree	312 (28.3)	194 (26.8)	13 (25.0)	6 (15.8)	17 (27.9)	82 (35.8)	0.14 <sup>b</sup>
Disagree	791 (71.7)	529 (73.2)	39 (75.0)	32 (84.2)	44 (72.1)	147 (64.2)	
<b>Public Displays (PUB)</b>							0.002 <sup>a</sup>
Agree	372 (33.7)	220 (30.4)	20 (38.5)	9 (23.7)	30 (49.2)	93 (40.6)	0.001 <sup>b</sup>
Disagree	731 (66.3)	503 (69.6)	32 (61.5)	29 (76.3)	31 (50.8)	136 (59.4)	
<b>Digital Media (DIG)</b>							<0.001 <sup>a</sup>
Agree	355 (32.2)	198 (27.4)	21 (40.4)	6 (15.8)	25 (41.0)	105 (45.9)	<0.001 <sup>b</sup>
Disagree	748 (67.8)	525 (72.6)	31 (59.6)	32 (84.2)	36 (59.0)	124 (54.1)	
<i>Sharing conventional tobacco-related information</i>							
<b>Friends and Family (FF)</b>							<0.001 <sup>a</sup>
Agree	322 (29.2)	163 (22.5)	18 (34.6)	11 (29.0)	20 (32.8)	110 (48.0)	<0.001 <sup>b</sup>
Disagree	781 (70.8)	560 (77.5)	34 (65.4)	27 (71.0)	41 (67.2)	119 (52.0)	
<i>Sharing e-cigarette-related information</i>							
<b>Friends and Family (FF)</b>							<0.001 <sup>a</sup>
Agree	248 (22.5)	104 (14.4)	15 (28.9)	3 (7.9)	22 (36.1)	104 (45.4)	<0.001 <sup>b</sup>
Disagree	855 (77.5)	619 (85.6)	37 (71.1)	35 (92.1)	39 (63.9)	125 (54.6)	

a Chi-squared p-values comparison across all tobacco use groups. b Chi-squared p-values comparing never users to ever users by communication channels. c Youth, school or community groups.

channel: FF (38.3%), YSCG (25.4%), BRO (43.9%), PRI (28.3%), PUB (33.7%), and DIG (32.2%). When examined by tobacco use status, more than half of e-cigarette-only users and polytobacco users indicated receiving e-cigarette-related information from FF (54.1% and 56.8%, respectively). Additionally, a considerable number of e-cigarette-only users acquired information via PUB (49.2%), and over half of polytobacco users (50.2%) received e-cigarette-related information from BRO. For all communication channels, never users and smokeless-

only users reported receiving e-cigarette information less frequently than cigarette-only users, e-cigarette-only users, and polytobacco users. Across the tobacco use groups, there was a significant difference in five of the communication channels: FF (p<0.001), BRO (p=0.007), PRI (p=0.035), PUB (p=0.002), and DIG (p<0.001). When comparing never users and ever users, FF (p<0.001), PUB (p=0.001), and DIG (p<0.001) were significantly different; however, BRO (p=0.77) and PRI (p=0.14) were not.

Cigarette-only users (34.6%), smokeless-only

users (29.0%), e-cigarette-only users (32.8%) and polytobacco users (48.0%) had higher proportions of participants who share conventional tobacco-related information with FF compared to never users (22.5%). For sharing e-cigarette-related information with FF, cigarette-only users (28.9%), e-cigarette-only users (36.1%), and polytobacco users (45.4%) had higher proportions compared to never users (14.4%). Smokeless-only users were least likely to share e-cigarette-related information with FF (7.9%). For sharing conventional tobacco-related information and e-cigarette-related information with FF, there were significant differences across all tobacco use groups ( $p < 0.001$  for both product types) and between never users and ever users ( $p < 0.001$  for both use groups).

### Associations between tobacco use status and each communication channel

Table 3 presents multivariable multinomial logistic regression models that evaluated the odds of being a tobacco user based on receiving tobacco-related (conventional or e-cigarette) information via six communication channels or sharing such information via FF. Appalachian youth who received conventional tobacco-related information from FF (AOR=1.87; 95% CI: 1.35–2.57), PUB (AOR=1.49; 95% CI: 1.09–2.05) and DIG (AOR=1.95; 95% CI: 1.41–2.70) had greater odds of being polytobacco users compared to never users. Participants who reported receiving conventional tobacco-related information from YSCG (AOR=0.69; 95% CI: 0.50–0.95) had lower odds of being polytobacco users compared to never users.

**Table 3. Multivariable multinomial logistic regression models of associations between tobacco use status and each communication channel (N=1103)**

Communication Channels-Agree	Cigarette		Smokeless		E-cigarette		Polytobacco	
	AOR <sup>a</sup>	95% CI						
<b>Receiving conventional tobacco-related information</b>								
Friends and Family (FF)	1.32	(0.75–2.34)	1.07	(0.55–2.08)	1.25	(0.74–2.13)	1.87	(1.35–2.57)
Youth, School, or Community Groups (YSCG)	0.70	(0.39–1.25)	0.63	(0.31–1.25)	0.85	(0.50–1.45)	0.69	(0.50–0.95)
Broadcast Media (BRO)	0.88	(0.49–1.56)	0.75	(0.39–1.48)	0.90	(0.53–1.53)	1.03	(0.75–1.41)
Print Media (PRI)	1.05	(0.58–1.91)	0.99	(0.48–2.05)	1.14	(0.66–1.98)	1.17	(0.84–1.62)
Public Displays (PUB)	0.95	(0.53–1.69)	0.49	(0.23–1.06)	1.35	(0.79–2.30)	1.49	(1.09–2.05)
Digital Media (DIG)	1.55	(0.87–2.77)	0.90	(0.43–1.88)	1.00	(0.58–1.74)	1.95	(1.41–2.70)
<b>Receiving e-cigarette-related information</b>								
Friends and Family (FF)	1.73	(0.97–3.06)	0.68	(0.31–1.46)	2.42	(1.42–4.13)	2.65	(1.93–3.65)
Youth, School, or Community Groups (YSCG)	0.96	(0.50–1.83)	0.28	(0.09–0.94)	0.82	(0.44–1.54)	1.15	(0.81–1.64)
Broadcast Media (BRO)	0.83	(0.46–1.48)	0.34	(0.15–0.78)	0.91	(0.53–1.56)	1.33	(0.97–1.82)
Print Media (PRI)	0.81	(0.42–1.57)	0.59	(0.24–1.44)	0.98	(0.54–1.77)	1.48	(1.06–2.08)
Public Displays (PUB)	1.34	(0.74–2.43)	0.86	(0.40–1.87)	2.13	(1.25–3.65)	1.62	(1.17–2.26)
Digital Media (DIG)	1.60	(0.89–2.89)	0.59	(0.24–1.46)	1.70	(0.98–2.94)	2.24	(1.61–3.12)
<b>Sharing conventional tobacco-related information</b>								
Friends and Family (FF)	1.77	(0.97–3.23)	1.30	(0.62–2.69)	1.62	(0.92–2.85)	2.91	(2.10–4.04)
<b>Sharing e-cigarette-related information</b>								
Friends and Family (FF)	2.25	(1.19–4.27)	0.48	(0.15–1.60)	3.16	(1.80–5.58)	4.48	(3.16–6.35)

<sup>a</sup> Adjusted odds ratios (AOR) and 95% confidence intervals adjusted for gender, school type (Middle vs High), and school state (KY vs NC vs NY). Age not included due to multicollinearity with school type. The exposure reference group: Disagree. The outcome reference group: Never Users.

There were no significant associations regarding the other tobacco use groups.

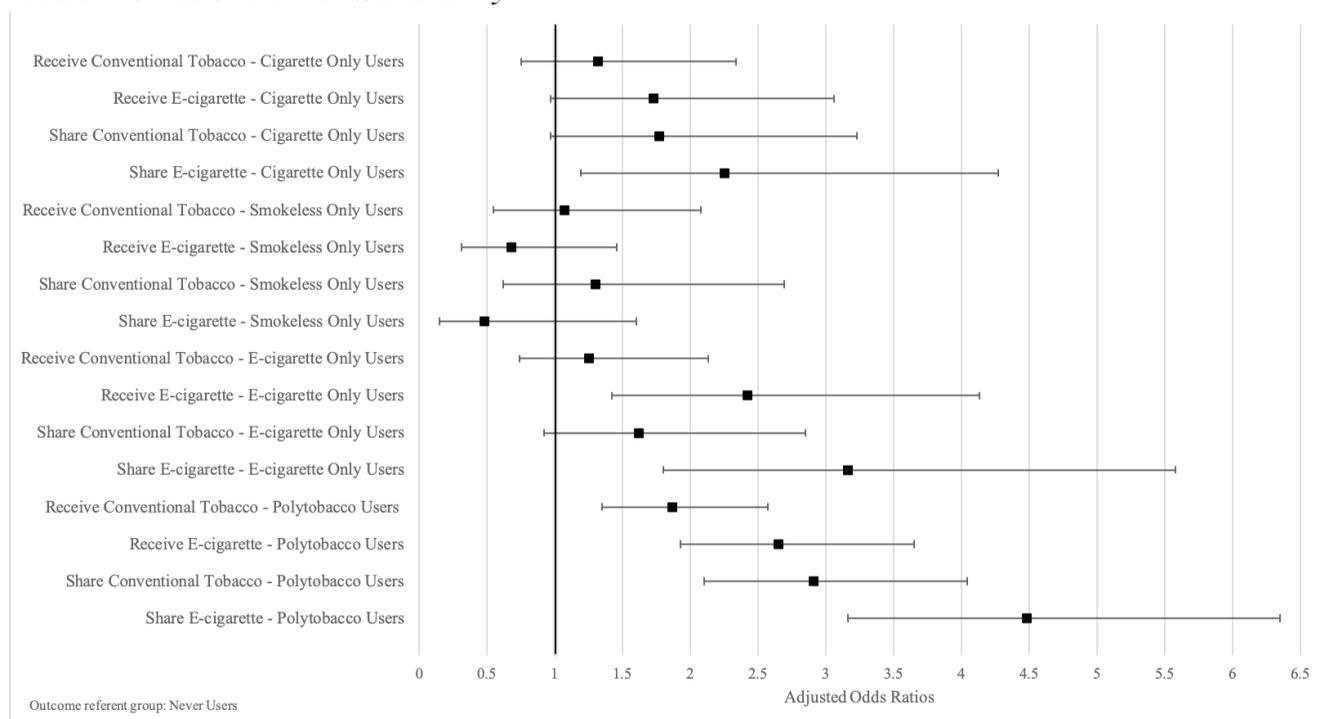
Participants who received e-cigarette-related information from FF had greater odds of being e-cigarette-only users (AOR=2.42; 95% CI: 1.42–4.13) and polytobacco users (AOR=2.65; 95% CI: 1.93–3.65) compared to never users. Participants who reported receiving such information via YSCG (AOR=0.28; 95% CI: 0.09–0.94) and BRO (AOR=0.34; 95% CI: 0.15–0.78) had decreased odds of being smokeless-only users. Additionally, participants who received e-cigarette-related information from PUB (AOR=2.13; 95% CI: 1.25–3.65) had increased odds of being e-cigarette-only users and from PRI (AOR=1.48; 95% CI: 1.06–2.08), PUB (AOR=1.62; 95% CI: 1.17–2.26), and DIG (AOR=2.24; 95% CI: 1.61–3.12) had increased odds of being polytobacco users compared to never users.

Participants who shared conventional tobacco-related information with FF had nearly three times the odds of being polytobacco users (AOR=2.91; 95% CI: 2.10–4.04) compared to never users. Participants who shared e-cigarette-related information had higher odds of being cigarette-only users (AOR=2.25; 95% CI: 1.19–4.27), e-cigarette-only users (AOR=3.16; 95% CI: 1.80–5.58), and

polytobacco users (AOR=4.48; 95% CI: 3.16–6.35) compared to never users.

Figure 1 shows adjusted odds ratios of the associations between tobacco use status and receiving and sharing tobacco-related information via FF. The strongest magnitudes of associations included sharing e-cigarette-related information among all tobacco use groups with exception of smokeless-only users where it is weakest. For cigarette-only users, e-cigarette-only users, and polytobacco users, the strengths of associations increase between receiving conventional tobacco-related information and sharing conventional tobacco-related information as well as between receiving e-cigarette-related information and sharing e-cigarette-related information. Additionally, for cigarette-only users and polytobacco users, the magnitudes of effects increase in order across receiving conventional tobacco-related information, receiving e-cigarette-related information, sharing conventional tobacco-related information, and sharing e-cigarette-related information. Associations for e-cigarette-only users were stronger for receiving and sharing e-cigarette-related information compared to receiving or sharing conventional tobacco-related information.

Figure 1. Adjusted odds ratios of associations between tobacco use status and receiving and sharing tobacco-related information via friends and family



## DISCUSSION

The exposure to tobacco-related information through specific communication channels was found to be significantly associated with patterns of use. Polyto tobacco use was associated with receiving conventional tobacco-related and e-cigarette-related information via FF, PUB and DIG, and with sharing such information via FF. Further, receiving e-cigarette-related information from FF and PUB was positively associated with e-cigarette-only use and from YSCG and BRO was negatively associated with smokeless only use. The highest prevalence of agreement with communication channel use and the strongest associations between sharing tobacco-related information with FF and tobacco use were related to polyto tobacco users. The strongest associations were found between sharing e-cigarette-related information and e-cigarette only use and polyto tobacco use. Despite a lack of precision, results from Figure 1 suggest a dose-response relationship between sharing e-cigarette-related information and patterns of tobacco use. Our findings suggest that widespread tobacco control efforts to reduce youth exposure to tobacco-related information via relevant communication channels may lessen or prevent both e-cigarette and polyto tobacco use. Health campaigns that prioritize salient communication channels to disseminate messages regarding the harms related to tobacco use among Appalachian youth may assist tobacco use prevention.

In our sample, FF and BRO were the most prevalent communication channels through which Appalachian youth received conventional tobacco-related (51.1% and 53.0%, respectively) and e-cigarette-related (38.3% and 43.9%, respectively) information. Further, FF was the most common channel through which e-cigarette-only users (54.1% and 54.1%, respectively) and polyto tobacco users (63.8% and 56.8%, respectively) received conventional tobacco-related information and e-cigarette-related information. These findings are consistent with prior qualitative investigations that examined ways in which adolescents receive tobacco-related information<sup>29,30</sup>. Adolescents indicated receiving most information on e-cigarettes from the media (e.g. advertisements and marketing), family, and peers<sup>29,30</sup>. Moreover, our findings indicate that receiving conventional tobacco-related information,

receiving e-cigarette-related information and sharing tobacco-related information through FF are positively associated with youth polyto tobacco use. Receiving e-cigarette-related information via FF and sharing e-cigarette-related information through this channel are positively associated with youth e-cigarette only use. Although communication channels through which youth receive and share tobacco-related information continue to diversify, research suggests that health messaging through avenues such as FF, rather than DIG and PRI, may engender a better understanding of tobacco-related harms among youth<sup>55</sup>. Our findings help clarify the associations between communication channels and youth tobacco use, and suggest that some channels may be more salient to youth tobacco users than others.

Many of the youth in our sample received information about tobacco products through media sources such as BRO, PUB, and DIG. Recent studies examining the prevalence of tobacco advertising report retail stores as the most common source of exposure, followed by sources such as the internet and television<sup>21,50</sup>. Our findings corroborate extant literature in which exposure to tobacco-related information is associated with youth tobacco receptivity or use<sup>23-28,48-51</sup>. For example, two studies using 2014 NYTS data found that exposure to various channels of advertisement (i.e. the internet, newspapers/magazines, retail stores, TV/movies) was associated with current e-cigarette use<sup>25,50</sup>. Another study found that youth who recalled retail e-cigarette marketing at baseline had nearly twice the likelihood of e-cigarette initiation at follow-up<sup>28</sup>. In our study, youth who indicated receiving information about e-cigarettes via FF and PUB were at least twice as likely to be e-cigarette-only users. These findings suggest that exposure to information regarding e-cigarettes is positively associated with e-cigarette use. Thus, and especially in light of the recent vaping-related illnesses and deaths<sup>56</sup>, it is important to better understand the influence of specific communication channels on the use of e-products.

Youth today access numerous communication channels to receive and share tobacco-related information on a seemingly ever-expanding set of tobacco products. This study found no significant

associations between receiving conventional tobacco-related information and cigarette only use. However, some communication channels were associated with e-cigarette only and polytobacco use. These channels may provide guidance in future anti-tobacco messaging for Appalachian youth. Given that tobacco acceptance and use rates are higher in the Appalachian region than other areas of the US and the strong ties with family, neighbors, and peers<sup>40,41</sup>, the finding that Appalachian youth receive information from FF is not unexpected. This same channel can be employed to deliver messaging regarding the dangers of youth conventional and e-tobacco product use. Trusted family members, friends and community leaders could be trained to raise youth awareness of the dangers of tobacco consumption, including use of e-nicotine products. Additionally, campaigns that educate parents and other caregivers with regard to not allowing tobacco use in homes and not allowing children to try tobacco products may be useful. Even adults who use tobacco, or are comfortable with such use, typically want healthy lives for their children. Beyond FF, receiving information via PUB was associated with e-cigarette only use and polytobacco use. Thus, youth in these rural areas may be especially influenced by materials displayed for public consumption (e.g. billboards, point-of-sale marketing). Whether or not such marketing intentionally targets youth, PUB was linked with participants trying tobacco. Thus, additional regulatory initiatives may be needed to lessen the likelihood of youth receiving pro-tobacco information via this communication channel. Given the changing tobacco product landscape, additional assessment of the channels, by which youth receive and share tobacco-related information, and their influence is needed, especially in youth most vulnerable to tobacco product initiation.

To our knowledge, this study is the first to evaluate the relationship between receiving or sharing tobacco-related information via various communication channels and tobacco use among Appalachian youth. Also, this study is one of the first to assess the association between exposure to or sharing of tobacco-related information and polytobacco use in a sample of youth. Although our findings align with the results of previous

investigations evaluating the effects of different forms of tobacco marketing and advertising on youth tobacco use<sup>23,25-28,48-51</sup>, some evidence suggests that Appalachian youth systematically differ in how they perceive and use tobacco compared to youth who reside elsewhere in the US<sup>38,40,41,57</sup>. For example, Appalachian youth are more likely to be exposed to tobacco products, live in communities where tobacco use is accepted, and use tobacco than other youth in the US<sup>38-41</sup>. Thus, additional research is needed to gain a deeper understanding of how and where youth receive tobacco-related information and how these factors shape tobacco initiation and continued use<sup>57-60</sup>.

### Limitations

Our study has some limitations. First, due to the cross-sectional nature of the data, we cannot assess changes over time. Second, our analysis had a small sample size of users of specific tobacco products. Third, participant data were self-reports and thus responses may be affected by associated biases (e.g. memory and social desirability). Despite these limitations, our findings provide evidence of relationships between exposure to tobacco-related information, via certain communication channels, and youth tobacco use including that of multiple products. These insights may be helpful in tobacco use prevention strategies that aim at limiting youth polytobacco use. Diligent monitoring of tobacco advertising and marketing is warranted in order to reduce youth tobacco use. FDA efforts in regulating tobacco-related messaging may help prevent tobacco use in youth who utilize specific communication channels to receive tobacco-related information. Additional research is needed to further clarify the influences and consequences of exposure to tobacco-related information on patterns of youth tobacco use, especially polytobacco use.

### CONCLUSIONS

Many Appalachian youth in our sample who used tobacco consumed more than one tobacco product (20.8%). This study reveals relationships between receiving and sharing tobacco-related information and youth tobacco use. In particular, receiving or sharing tobacco-related information via friends and family as well as public displays was associated with e-cigarette only use; whereas receiving or sharing tobacco-related

information via friends and family; youth, school and community groups; print media; and digital media was associated with polytobacco use. In addition, sharing e-cigarette-related information was linked to cigarette only use, e-cigarette only use, and polytobacco use. As health communication campaigns are developed, consideration should be given to channels employed and, when possible, distributing messages via multiple channels. Limitations on and monitoring of tobacco marketing and advertising, especially when youth are targeted, should continue and be strictly enforced. Given the number of polytobacco users in this study, devoting additional attention to educating youth on the dangers of tobacco use, especially the use of multiple tobacco products, is warranted.

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