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The Use of Alternative Tobacco Products and Associated Factors among School-going Youth in Central Appalachia

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Abstract

Objective: To examine alternative tobacco product (ATP) use and associated factors among middle school students in Appalachian Tennessee.

Method.—Data (2015-2016; N=573) from school-based tobacco surveys in 11 middle schools in Appalachian Tennessee were analyzed. Multiple logistic regression model described factors associated with ATP use.

Results.—Over one-tenth (13.2%) of participants have ever used ATPs. Approximately 9%, 7%, 6%, and 2% of participants have ever used e-cigarettes, cigarettes, smokeless tobacco, and little cigars or cigarillos, respectively. The adjusted analysis shows that the following were significantly associated with ever use of ATPs: believing tobacco users have more friends, owning tobacco-branded item(s), living with a tobacco user, having ever smoked cigarettes, and living in homes where smoking is allowed.

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Conflict of interest

Authors declare no conflict of interest.

Conclusion: More than one in 10 of the participants have ever used at least one ATP, and the association with desirable objects and situations may promote ATP use. Thus, interventions should seek to reduce these positive images of tobacco by making all tobacco products unappealing to youth.

Keywords

Alternative tobacco products; Appalachian Tennessee; tobacco; middle school students; youth

Tobacco use in the United States (U.S.) has declined from one-in-two adults in the 1950s and 1960s to less than one-in-five currently.¹ However, this decline has not been uniform across the country, with large disparities among population subgroups and geographic areas. The significance of this phenomenon is reflected in the *Healthy People 2020* goal that aims to eliminate disparities in tobacco use and tobacco-induced diseases in order to attain 12% adult smoking rate in the U.S. by 2020.² In places such as Central Appalachia, a predominantly rural and understudied area with underserved and disadvantaged populations,^{3,4} the prevalence of tobacco use is significantly higher than the national average.⁴ This situation suggests that national and statewide policies and programs that have contributed to the nationwide decline in tobacco use since the mid-20th century have not had the intended impact in the Central Appalachian region. It also illuminates some of the particular qualities of the region. Hence, there is a need for region-specific research to address this tobacco epidemic in Central Appalachia.

Tobacco use consists of a broad array of combustible and non-combustible tobacco products.¹ There is an uptake of non-cigarette or alternative tobacco products (ATPs) such as hookahs/waterpipes, smokeless tobacco (SLTs), and electronic cigarettes (e-cigarettes) among youth in the U.S.^{1,5} Specifically, the National Youth Tobacco Survey (NYTS) data showed that the use of e-cigarettes among middle school children increased from 0.6% in 2011 to 3.9% in 2014.⁶ Additionally, the NYTS data showed that while the prevalence of current cigarette use among middle school children was 2.5% in 2014, that of ATPs such as e-cigarettes, hookahs, cigars, and smokeless tobacco was 3.9%, 2.5%, 1.9%, and 1.6%, respectively.⁵ The evidence about the use of ATPs among children in population subgroups and across geographic areas that can inform preventive initiatives is, however, sparse. Given that 90% of regular tobacco users began the behavior prior to the age of 18 years, research and intervention efforts are needed targeting children and adolescents.^{6–8} This is critical because estimates show that decreasing adolescent smoking by 25% would result in an annual savings of 100,000 lives.⁹ Thus, addressing the experimentation and use of ATPs in the U.S. will likely reduce nicotine addiction and transitioning into conventional cigarette smoking, thereby reducing the risk of premature deaths due to tobacco use.

Nationally, it was estimated that 2.4 million and 1.6 million middle and high school students used e-cigarettes and hookahs, respectively, in 2014.^{5,9} Although limited subgroup and region-specific studies on ATPs exist, a study involving 11th and 12th graders in Southern California found that prevalence of hookah, e-cigarettes, and smokeless tobacco was 10.7%, 9.6%, and 2.2%, respectively.¹⁰ In places such as Tennessee where the prevalence of tobacco use among adults is higher than the national rate,⁴ little research has, however, been done on

the use of ATPs among youth.¹¹ This study fills this gap by investigating the use of ATPs among youth in Tennessee, where tobacco control lags behind many states.^{12,13} Specifically, we aimed to assess the use of ATPs among middle school students in Northeast Tennessee, a part of the Central Appalachian region where the tobacco use prevalence among adults for the eight counties ranged from 23% to 40% in 2014.¹⁴ The goal of the study is to spur discussions for the state of Tennessee to diligently enforce existing youth policies pertaining to tobacco use, the 1994 Prevention of Youth Access to Tobacco Act that prohibited the sale of combusted and smokeless tobacco products to youth aged 18 years and under, the 1995 Children's Act for Clean Indoor Air that banned smoking in indoor areas opened to children and the public, and the 2007 Non-Smoker Protection Act that banned smoking in most enclosed places;¹⁵ and e-cigarette use in particular.¹⁴

Although there is an ongoing national effort to regulate ATPs in the country through the Food and Drug Administration's Deeming Rule,¹⁶ evidence shows that tobacco regulations beginning at the local level have been more successful than those beginning at the state and national levels.¹⁷ Thus, a region-specific intervention in Northeast or Appalachian Tennessee has a great potential in reducing the high prevalence of tobacco use in the region. Consequently, in 2015 our research team was contracted by the Tennessee Health Department to develop a comprehensive plan to prevent tobacco use initiation, protect non-smokers against exposure to secondhand smoke, and to promote tobacco use cessation in Northeast Tennessee. We identified the lack of research on youth tobacco use in the region as a major challenge to tobacco control in the region.¹⁴ The present study is an integral part of our efforts to fill this gap by generating data to guide the region-specific tobacco initiation interventions in the Appalachian Tennessee.

Methods

Participants.

This study was approved by the institutional review board (IRB) of the corresponding author's institution.

Data were obtained from a school-based tobacco use survey, Youth Tobacco Survey, conducted in two predominantly rural Central Appalachian counties^{3,18} in Northeast Tennessee in 2015-2016. The Department of Health initiated the school survey to obtain data on the use of tobacco products, including cigarettes, smokeless tobacco use, e-cigarette, cigar, and cigarillos among school-going children and adolescents. Letters were sent to the children's parents/legal guardians explaining the nature of the survey and date of administration. Both passive and active consent procedures were used to obtain parent/legal guardian's consent for their children to participate in the survey. The participation of the students in the study was voluntary, and all parents/legal guardians had the opportunity—without any retribution—to refuse or retract permission if they did not consent to the participation of their children in the survey. All students whose parents/legal guardians provided informed consent and who were present in class on the day of the survey were invited to participate in the study. Approximately 51% of eligible participants participated in the survey. As part of the process, the researchers agreed to make the survey anonymous with no ability to trace responses to any individual student and to collect very limited

demographic information. Data (N=573) used in this analysis were obtained from surveys administered to students in grades 6 to 8. Overall, 11 middle schools participated in the survey.

The survey questionnaire contained 27 items: 24 questions on tobacco use, perception, and exposure to tobacco use by people living with the student, and three demographic information questions. The tobacco-related questions were adopted from the NYTS questionnaire.¹⁹

Study variables.

Dependent variable.—The main outcome variable was ever-use of ATPs, defined as any non-cigarette products, including chewing tobacco, e-cigarettes, snuff, dip, cigars, cigarillos, hookah, waterpipe, snus, bidis, pipes, and dissolvable tobacco. This variable was ascertained by the questions: “Have you ever tried chewing tobacco, snuff, or dip such as Redman or Skoal?” (Yes/No), “Have you ever tried cigars or cigarillos (little cigars)?” (Yes/No), “Have you ever tried electronic cigarettes, even one or two puffs?” (Yes/No), and “Have you ever tried any other tobacco products not mentioned previously, such as hookah, waterpipe, snus, bidis, or dissolvable tobacco products (e.g., Ariva, Stonewall, Camel orbs, sticks or strips)?” (Yes/No). Participants were considered to have used ATPs if they answered “Yes” to any of the questions. Participants who answered “No” to all the questions were deemed to have never used ATPs. To calculate the prevalence of ever use of ATPs, we classified tobacco products into cigarettes, smokeless tobacco (chewing tobacco, snuff, or dip), cigars or cigarillos, e-cigarettes, other tobacco products (hookah, waterpipe, snus, bidis, or dissolvable tobacco products) and ATPs (all non-cigarette products).

Independent variables.—The selection of independent variables was based on the Ecological Model of Health (EMH),^{20,21} which was developed to redirect public health promotion to factors outside the individual that affect individual’s behavior.²² We, therefore, included intrapersonal (age, sex, grade, perception of harm, the belief that tobacco users have more friends), interpersonal (peer or family pressure, living with a tobacco user), and environmental (owning tobacco-branded item(s), home smoking rules) factors. The belief that tobacco users have more friends was assessed by the question, “Do you think young people who smoke cigarettes have more friends?” (Yes/No), whereas owning tobacco-branded item(s) was measured by the question, “Have you ever bought or received anything such as a lighter, t-shirt, hat, sunglasses, or other items that have a tobacco brand name or picture on it?” (Yes/No). Pressure to use tobacco product was assessed by the question, “Have you felt pressured by a friend or family member to use tobacco products?” (Yes/No). Perception of harm was assessed for all tobacco products by the question, “How strongly do you agree or disagree with the statement “All tobacco products are dangerous?” [Strongly agree, Agree, Disagree, Strongly disagree]. Participants who answered “Strongly agree” or “Agree” were considered to perceive tobacco products as harmful, while those who responded “Disagree” or “Strongly disagree” were classified as those who believed tobacco products or some products are not harmful. Home smoking rules were categorized into *smoking allowed*, *smoking restriction* (homes in which smoking is not allowed but with exception), and *smoke-free* (homes in which smoking is completely not allowed).

Participants were considered to be living with a tobacco user if they reported that at least one member of the household uses tobacco. Age was classified into below 13 years and 13 years and older, while sex was categorized as male and female and grade as 6th, 7th, and 8th grades.

Statistical analysis.

Descriptive analysis was conducted to describe participant characteristics and proportions of participants in the categories of the outcome and independent variables. Prevalence of ever-use of ATPs in the categories of independent variables were compared using chi-square tests. We calculated prevalence of ever-use of the four categories of ATPs (smokeless tobacco, cigars or cigarillos, e-cigarettes, and all other non-cigarette tobacco products). Due to the small sample size, we could not conduct multinomial logistic regression to examine factors associated with ever-use of multiple ATPs so we examined factors associated with any ever-use of ATPs. A multiple logistic regression model was performed to assess the associations between independent variables and ever-use of ATPs. The binary variable “ever-use of ATP” (1 = ever used, 0 = never used) was the dependent variable in the model. The Full Information Maximum Likelihood estimation (FIML)²³ method in Mplus²⁴ was used to conduct the logistic regression analyses in order to account for missing data in the analysis. By using the FIML estimation method, any participant with at least one valid data point was incorporated into the analysis.²³ The FIML was appropriate because it has been found to yield less bias than other methods of handling missing data in regression.²³ The significance level was set at 0.05 at two sides. Data management and descriptive statistics were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA), and the multiple logistic regression analysis was performed in Mplus version 7.4.²⁴ We report adjusted odds ratios (ORs) and the associated 95% confidence intervals (CI).

Results

Participant characteristics and prevalence of ever use of ATPs.

Table 1 illustrates the characteristics of the analytic sample. Of the 573 participants, 52.9% were females, and 26.9%, 29.1%, and 43.5% were in 6th, 7th, and 8th grades, respectively. Age ranged from 10 to 15 years (Mean=12.55±2.4), with 38.6% under the age of 13 years. Additionally, 5.1% of participants currently used tobacco products (i.e., used any tobacco product in the past 30 days). Half of the participants (50%) believed that people who smoke tobacco have more friends and 7.2% had ever smoked cigarettes.

Table 2 shows the prevalence of ATP use among the study sample. Overall, 13.2% of the participants had ever used ATPs (9.3% females; 17.4% males). The prevalence of ever-use of ATPs was similar for participants under 13 years old and those over 13 years old (13.4% vs. 12.2%, $p=0.6840$). Among participants who were exposed to tobacco promotion, 54.0% had ever used ATPs, whereas 53.9% of those who reported having been pressured to use tobacco had ever used ATPs. About one in five (20.7%) of those who did not perceive tobacco products as dangerous had ever used ATPs, compared with 12.0% of those who agreed that all tobacco products are dangerous.

Table 3 shows the pattern of use of the four types of ATPs considered in this study. E-cigarettes were the most commonly used products (9.3%), followed by smokeless tobacco (5.9%). The most commonly dual ever use products were e-cigarettes and smokeless tobacco (3.7%), followed by e-cigarettes and little cigar/cigarillos (1.6%). Overall, 8.6%, 2.6%, 0.2%, and 1.2% had ever used only one ATP, two ATPs, three ATPs, and all four ATPs, respectively. Thus, about 4% of the participants had ever used more than one ATP.

Factors associated with ever-use of ATPs among the middle school students.

Table 4 shows factors associated with ATP use. Controlling for the effects of all other independent variables in the model, participants in grade 7 had greater odds of ATP use than those in grade 8 (OR=5.39, 95% CI=1.55 – 18.74). Participants who believed that tobacco users have more friends had increased odds of ATP use compared with those who did not hold this view (OR=6.93, 95% CI=2.75 – 17.44). The odds of ATP in participants exposed to tobacco promotion were more than six times the odds in those not exposed to tobacco promotion (OR=6.36, 95% CI=2.69 – 15.04). Compared with participants who did not believe that all tobacco products are dangerous, those who perceived all tobacco products as dangerous had 69% decreased odds of ATP use (OR=0.31, 95% CI=0.11 – 0.88). Additionally, living with a tobacco user, living in homes where smoking is allowed and ever cigarette smoking were associated with significant increases in the odds of ATP use (see Table 4).

Discussion

Major disparities exist in the prevalence of tobacco use in the U.S., with the highest prevalence in counties in the Central Appalachian region.⁴ These disparities suggest that research into tobacco use in the region is critically needed in order to achieve the goal of reducing such disparities and achieving adult smoking rate of 12%.² Since the region has unique features²⁵ that limit the impact of national and statewide policies and programs,¹⁴ this study was conducted to estimate the prevalence and multiple use of ATPs and identify correlates of use in school-going youth to inform prevention initiatives. Consistent with the literature,¹¹ it was found in this study that e-cigarette use has surpassed all other tobacco products considered. Alternative tobacco product use is more common than conventional cigarettes among students. The results of the study also revealed evidence of multiple use of ATPs among the participants.

This study adds to the growing evidence of the uptake of ATPs among population subgroups,^{26,27} as the use of conventional cigarettes continues to decline.¹ These new or emerging products have been advertised as risk reduction devices by the tobacco industry, or alternative products to use in places where conventional cigarette smoking is not allowed.²⁸ There are concerns that the use of these products, besides health effects, could lead to transition into conventional cigarette smoking and erode public health gains in tobacco control, and that dual- and poly- products will increase the risk of addiction.^{29–31} Thus, the results of this study highlight the need to monitor use of ATPs carefully because more children and adolescents may be using these products because of their appeal due to marketing and promotion by the tobacco industry.

In the multiple logistic analysis, it was found that age and sex were not significantly associated with ATP use, although the odds ratios were in the expected direction: the odds were increased in males and participants older than 12 years. This generates the need for a further study with a larger sample to evaluate the impact of demographic factors on ATP use in this population.

The results show that perceiving all tobacco products as dangerous was associated with decreased odds of ATP use. This finding is consistent with studies that found that adolescents who held high perception of smoking-related risks were less likely to initiate smoking,³² and believing that smoking is addictive and the deleterious health effects occur in the short term deter youth from tobacco use.³³ Although some tobacco products may be less risky than others,^{34,35} the exposure to all types of tobacco products in youth is a public health concern. This is because of the risk of addiction to nicotine and subsequent tobacco dependence.⁶ The finding in the present study suggests that youth-specific anti-smoking messages that highlight the danger of experimentation with tobacco products may dissuade youths from the use of alternative tobacco products, which have been marketed with reduced risk claims. Thus, school-based tobacco control programs should include lessons on nicotine and the dangers associated with exposure to nicotine in all tobacco products.

The results of the study show that the perception that tobacco users have more friends, and owning tobacco-branded item(s) were significantly associated with increased odds of ever-use of ATPs. Alternative tobacco products such as hookah have been promoted for social use,³⁶ which may account for the significant association with the perception identified in our study that tobacco users have more friends. Similar to these results, a survey conducted among adolescents in Massachusetts found a relationship between owning tobacco-branded items and subsequent smoking.³⁷ It was found in that study that owning tobacco-branded items and being able to name the brand that caught attention increased the odds of initiating smoking by more than two times (OR=2.70, 95% CI= 1.24, 5.85), compared with neither owning such items nor being able to name a brand.³⁷ These branded items may promote tobacco use among youth through association of tobacco with objects that are desirable or everyday objects, which pose no risk to the owner, leading to the development of positive *affect* towards tobacco use.³⁸ Thus, like the advertising, marketing, and promotion of cigarettes that were curtailed by the Master Settlement Agreement (MSA),³⁹ there is an urgent need to curtail such activities for ATPs as they enhance use. Indeed, the findings of our study support the Food and Drug Administration (FDA)'s "Deeming" regulation that extended the coverage of tobacco regulations to all ATPs.¹⁶ Although the FDA is in the process of regulating these products, evidence shows that a tobacco regulation beginning at the local level is more powerful than a regulation that begins at the national level.¹⁷ Thus, Northeast Tennessee region may need to further develop stricter laws or strengthen the enforcement of the existing laws to prevent tobacco promotion to youth and youth access to tobacco souvenirs. This can only be possible through the repeal of preemption of tobacco regulation in the state.⁴⁰

It has been reported that the smoking status of parents and friends predict the onset of smoking,^{41,42} and living in smoke-free homes prevent smoking initiation.⁴³ Our results showed that, controlling for other variables in the model, participants who reported having

been pressured to smoke in the past year, those living with tobacco users, and participants living in homes where smoking is allowed had a significant increase in the odds of ATP use. As these results are consistent with the existing literature,^{41–43} they suggest the need for comprehensive state-wide policy that incorporates ATPs, and school-based tobacco control programs aimed at associating tobacco products with negative images to counteract the tobacco industry advertising claims, similar to the “Truth!” campaign.⁴⁴

This study has limitations that must be taken into consideration when interpreting the results. First, the data were collected by self-report, making the study susceptible to recall and social desirability biases; however, the validity of self-report method can be enhanced when privacy and confidentiality are assured,⁴⁵ as was done in the data collection for this study. Additionally, if these biases occurred, it would rather lead to underestimation of the prevalence of the use of the tobacco products. Thus, controlling such biases will strengthen, instead of weaken, the study results. Second, because of the anonymity agreement between the participating schools and the Department of Health, our study could not assess other important variables that may influence the use of ATPs such as family socioeconomic status and ethnicity (as this information was not available). Third, since the study is correlational, temporality cannot be established. Fourth, when comparing the results with other studies, readers should consider that this study measured ever use of ATPs which includes experimentation with the products. Despite these limitations, the study contributes to the sparse evidence on the use of ATPs among population subgroups and efforts to address disparities in tobacco use in communities across the U.S. Moreover, with the involvement of 11 schools in the study, the results can fairly be extrapolated to school-going youth in the region.

Conclusion.

The Central Appalachian region of the U.S. has unique characteristics that have likely contributed to the high prevalence of ever use of ATPs. Simultaneously, there is a nationwide uptake of novel tobacco products that the tobacco industry portrays as harm-reduction devices, and marketed strategically to increase their appeal through positive association with desirable things and situations, such as independence. With Tennessee being the third largest tobacco-growing state—with a near absence of information on youth use of ATPs—this study provides information to aid communities in Appalachian Tennessee and the entire Central Appalachian region in preventing ATP use and for policy development and advocacy initiatives. The results showed that ATP use is more common than conventional cigarettes and there are no demographic differences in the use of these products. Additionally, the results suggest that positive images of tobacco products may promote ATP use. Thus, interventions should seek to reduce these positive images of tobacco by replacing them with negative ones to make tobacco unappealing to the youth. Ultimately, more studies are required to monitor ATP use and to inform community-based interventions in this high-risk population.

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References

1. USDHHS. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014.
2. CDC. National Center for Health Statistics: Healthy People 2020. Available at http://www.cdc.gov/nchs/healthy_people/hp2020.htm Published 2015.
3. Roehrich-Patrick L, Moreo B. Just How Rural or Urban Are Tennessee's 95 Counties Tennessee Advisory Commission on Intergovernmental Relations. Nashville, Tennessee; 2016 Available at <https://www.tn.gov/assets/entities/tacir/attachments/2016JustHowRuralOrUrban.pdf>
4. Robert Wood Johnson Foundation. County Health Rankings & Roadmaps: Tennessee State Health Gaps Report. Robert Wood Johnson Foundation, 2016 Available at <http://www.countyhealthrankings.org/health-gaps/tennessee>.
5. Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students - United States, 2011-2014. MMWR Morb Mortal Wkly Rep. 2015;64(14):381–385. <http://www.ncbi.nlm.nih.gov/pubmed/25879896>. [PubMed: 25879896]
6. Farber HJ, Nelson KE, Groner JA, et al. Public Policy to Protect Children From Tobacco, Nicotine, and Tobacco Smoke. Pediatrics. 2015;136(5):998–1007. doi:10.1542/peds.2015-3109. [PubMed: 26504133]
7. CDC. Youth and tobacco use. Centers for Disease Control and Prevention, 2015 Available at http://www.cdc.gov/tobacco/data_statistics/fact_sheets/youth_data/tobacco_use/.
8. USDHHS. Preventing Tobacco Use Among Youth and Young Adults A Report from the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2012.
9. Marshall JR, Lotfipour S, Chakravarthy B. Growing Trend of Alternative Tobacco Use Among the Nation's Youth: A New Generation of Addicts. West J Emerg Med. 2016;17(2):139–142. doi:10.5811/westjem.2016.1.29383. [PubMed: 26973738]
10. Gilreath TD, Leventhal A, Barrington-Trimis JL, et al. Patterns of Alternative Tobacco Product Use: Emergence of Hookah and E-cigarettes as Preferred Products Amongst Youth. J Adolesc Health. 2016;58(2):181–185. doi:10.1016/j.jadohealth.2015.10.001. [PubMed: 26598059]
11. Owusu D, Aibangbee J, Collins C, et al. The Use of E-cigarettes Among School-Going Adolescents in a Predominantly Rural Environment of Central Appalachia. J Community Health. 2017;42(3):624–631. doi:10.1007/s10900-016-0297-0. [PubMed: 27868166]
12. American Lung Association. State of Tobacco Control-Tennessee. <http://www.lung.org/our-initiatives/tobacco/reports-resources/sotc/?setstate=TN>. Published 2016 Accessed December 31, 2016.
13. CDC. Smoking and Tobacco use. State highlights - Tennessee. Centers for Disease Control and Prevention, 2014 Available at http://www.cdc.gov/tobacco/data_statistics/state_data/state_highlights/2012/states/tennessee/index.htm.
14. Mamudu MH, Littleton AM, Wang L. Regional Population Health Improvement Plan: Tobacco Cessation in tobaccoTennessee. Johnson City, Tennessee; 2015 Available at <https://www.etsu.edu/cph/hsmptobaccopolicy/documents/simreport2016.pdf>

15. Mamudu MH, Dadkar S, Veeranki SP, et al. Tobacco Control in Tennessee: Stakeholder Analysis of the Development of the Non-Smoker Protection Act, 2007 <http://escholarship.org/uc/item/8z38c04x>. Published 2012. Accessed January 3, 2016.
16. Backinger CL, Messiner HI, Ashley DL. The FDA “Deeming Rule” and Tobacco Regulatory Research. *Tob Regul Sci*. 2016;2(3):290–293. doi:10.18001/TRS.2.3.8. [PubMed: 29423429]
17. Dachille KH. Using law to improve public health: The example of tobacco regulation. *Heal Law J* (New York State Bar Assoc. 2012;17(2):32–37.
18. Rural Health Services Consortium Inc. Rural Health Services Area of Operation. Rural Health Services Consortium Inc Available at <http://rhcctn.com/service-area/>.
19. CDC. Smoking & Tobacco use: National Youth Tobacco Survey (NYTS). Centers for Disease Control and Prevention, 2016 Available at http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/.
20. Bronfenbrenner U Toward an Experimental Ecology of Human Development. *Am Psychol*. 1977;32(7):513–531.
21. McLeroy RK, Bibeau D, Steckler A et al. An ecological perspective on health promotion programs. *Health Educ Q*. 1988;14(4):351–377.
22. WHO. The ecological framework. World Health Organization, 2017 Available at <http://www.who.int/violenceprevention/approach/ecology/en/>.
23. Enders CK. The performance of the full information maximum likelihood estimator in multiple regression models with missing data. *Educ Psychol Meas*. 2001;61(5):713–740. doi: 10.1177/0013164401615001.
24. Muthén KL, Muthén OB. Mplus User’s Guide. Sixth Edit. Los Angeles, CA: Muthén & Muthén; 2010 Available at <https://www.statmodel.com/download/usersguide/MplusUsersGuidev6.pdf>.
25. Fallin A, Glantz SA. Tobacco-control policies in tobacco-growing states: where tobacco was king. *Milbank Q*. 2015;93(2):319–358. doi:10.1111/1468-0009.12124. [PubMed: 26044632]
26. Regan AK, Dube SR, Arrazola R. Smokeless and flavored tobacco products in the U.S.: 2009 Styles survey results. *Am J Prev Med*. 2012;42(1):29–36. doi:10.1016/j.amepre.2011.08.019. [PubMed: 22176843]
27. Leventhal AM, Strong DR, Kirkpatrick MG, et al. Association of Electronic Cigarette Use With Initiation of Combustible Tobacco Product Smoking in Early Adolescence. *JAMA*. 2015;314(7): 700. doi:10.1001/jama.2015.8950. [PubMed: 26284721]
28. Mejia AB, Ling PM. Tobacco industry consumer research on smokeless tobacco users and product development. *Am J Public Health*. 2010;100(1):78–87. doi:10.2105/AJPH.2008.152603. [PubMed: 19910355]
29. de Andrade M, Hastings G, Angus K. Promotion of electronic cigarettes: tobacco marketing reinvented? *BMJ*. 2013;347:f7473. [PubMed: 24361526]
30. Voigt K Smoking Norms and the Regulation of E-Cigarettes. *Am J Public Health*. 2015;105(10): 1967–1972. doi:10.2105/AJPH.2015.302764. [PubMed: 26270285]
31. Hatsukami DK, Lemmonds C, Tomar SL. Smokeless tobacco use: harm reduction or induction approach? *Prev Med* (Baltim). 2004;38(3):309–317. doi:10.1016/j.ypmed.2003.10.006.
32. Song A V, Glantz SA, Halpern-Felsher BL. Perceptions of second-hand smoke risks predict future adolescent smoking initiation. *J Adolesc Heal*. 2009;45(6):618–625. doi:10.1016/j.jadohealth.2009.04.022.
33. Gerking S, Khaddaria R. Perceptions of health risk and smoking decisions of young people. *Heal Econ* (United Kingdom). 2012;21(7):865–871. doi:10.1002/hecl.1760.
34. Rodu B, Godshall WT. Tobacco harm reduction: an alternative cessation strategy for inveterate smokers. *Harm Reduct J*. 2006;3(37):1–23. doi:10.1186/1477-7517-3-37. [PubMed: 16403229]
35. Polosa R, Rodu B, Caponnetto P et al. A fresh look at tobacco harm reduction: the case for the electronic cigarette. *Harm Reduct J*. 2013;10(1):19. [PubMed: 24090432]
36. Sterling KL, Fryer CS, Majeed B et al. Promotion of waterpipe tobacco use, its variants and accessories in young adult newspapers: A content analysis of message portrayal. *Health Educ Res*. 2015;30(1):152–161. doi:10.1093/her/cyu035. [PubMed: 24957675]

37. Biener L, Siegel M. Tobacco marketing and adolescent smoking: More support for a causal inference. *Am J Public Health*. 2000;90(3):407–411. doi:10.2105/AJPH.90.3.407. [PubMed: 10705860]
38. Pollay RW, Dewhirst T. The dark side of marketing seemingly “Light” cigarettes: successful images and failed fact. *Tob Control*. 2002;11 Suppl 1:I18–31. [PubMed: 11893811]
39. Public Health Law Center. Tobacco Control: Master Settlement Agreement. Available at <http://publichealthlawcenter.org/topics/tobacco-control/tobacco-control-litigation/master-settlement-agreement>.
40. Mamudu HM, Veeranki SP. Tennessee’s smokefree policy: it’s time for local control. *Tenn Med*. 2013;106(9):37–41.
41. Villanti A, Boulay M, Juon H- S. Peer, parent and media influences on adolescent smoking by developmental stage. *Addict Behav*. 2011;36(1-2):133–136. doi:10.1016/j.addbeh.2010.08.018. [PubMed: 20855170]
42. de Vries H, Engels R, Kremers S et al. Parents’ and friends’ smoking status as predictors of smoking onset: findings from six European countries. *Health Educ Res*. 2003;18(5):627–636. <http://www.ncbi.nlm.nih.gov/pubmed/14572021>. [PubMed: 14572021]
43. Bernat DH, Erickson DJ, Widome R et al. Adolescent Smoking Trajectories: Results from a Population-Based Cohort Study. *J Adolesc Heal*. 2008;43(4):334–340. doi:10.1016/j.jadohealth.2008.02.014.
44. The Truth. Smoking = Less Cash = Less Time: Hanging With The Squad. Available at <https://www.thetruth.com/articles/videos/squadless?source=ASMSEARCH&gclid=CJC0gMTexNICFYk2gQodGJ4Bkw>. Accessed March 7, 2017
45. Caraballo RS, Giovino G a, Pechacek TF Self-reported cigarette smoking vs. serum cotinine among U.S. adolescents. *Nicotine Tob Res*. 2004;6(1):19–25. doi: 10.1080/14622200310001656821. [PubMed: 14982684]

Table 1:

The characteristics of participating school-going students in Appalachian Tennessee, 2015-2016 (N=573)

Variables	Frequency	Percent (%)
Sex		
Female	303	52.9
Male	259	45.2
Unknown	11	1.9
Age		
<13 years	352	61.4
13 years	221	38.6
Grade		
6th	154	26.9
7th	167	29.1
8th	249	43.5
Unknown	3	0.5
Believe smokers have more friends		
No	281	49.0
Yes	288	50.3
Unknown	4	0.7
Own tobacco-branded item(s)		
No	485	84.6
Yes	87	15.2
Unknown	1	0.2
Perceive tobacco products to be harmful		
No	59	10.3
Yes	507	88.5
Unknown	7	1.2
Peer or family pressure to use tobacco		
No	502	87.6
Yes	65	11.3
Unknown	6	1.1
Living with a tobacco user(s)		
No	275	48.0
Yes	276	48.2
Unknown	22	3.8
Home smoking rules		
Smoking allowed	64	11.2
Smoking restricted	98	17.1
Smoking not allowed	400	69.8
Unknown	11	1.9
Ever smoked cigarettes		
No	518	92.8

Variables	Frequency	Percent (%)
Yes	41	7.2
Unknown	14	2.4
Total	573	100.0

Data source: 2015-2016 Youth Tobacco Survey, Appalachian (or Northeast) Tennessee

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Table 2:

Prevalence of ever-use of alternative tobacco products (ATPs) among middle school students in Appalachian Tennessee, 2015-2016 (N=573)

Variables	Prevalence (%)	P-value
Sex		0.0045
Female	9.3	
Male	17.4	
Age		0.6840
<13 years	13.4	
13 years	12.2	
Grade		0.7760
6th	12.3	
7th	14.4	
8th	12.1	
Believe smokers have more friends		<0.0001
No	3.2	
Yes	22.6	
Owned tobacco-branded item(s)		<0.0001
No	5.6	
Yes	54.0	
Perceive tobacco products to be harmful		0.0626
No	20.7	
Yes	12.0	
Peer or family pressure to use tobacco		<0.0001
No	7.8	
Yes	53.9	
Living with a tobacco user(s)		<0.0001
No	1.8	
Yes	23.9	
Home smoking rules		<0.0001
Smoking allowed	60.9	
Smoking restricted	16.3	
Smoking not allowed	4.8	
Ever smoked cigarettes		<0.0001
No	7.1	
Yes	85.4	
Total	13.2	

Data source: 2015-2016 Youth Tobacco Survey, Appalachian (or Northeast) Tennessee

Table 3:

Pattern of ever use of alternative tobacco products (ATPs) among middle school students in Appalachian Tennessee, 2015-2016 (N=573)

	Prevalence of ever use (%)	E-cigarettes (%)	Smokeless tobacco (%)	Other non- cigarette products (%)	Exclusive use (%)	Used this product and one other ATP (%)	Used this product and two other ATPs (%)
LCC	2.1	1.6	1.4	1.2	0.5	0.2	0.2
E-cigarettes	9.3		3.7	1.2	5.1	2.4	0.2
Smokeless tobacco	5.9			1.4	2.1	2.4	0.2
Other non-cigarette products	2.2				0.9	0.2	0.0

Note: LCC, little cigar and cigarillos

Table 4:

Multiple logistic regression analysis for the association between independent factors and ever-use of alternative tobacco products (ATPs) among middle school students in Appalachian Tennessee, 2015-2016 (N=573)

Variable	aOR	95% CI	P-value
Sex			
Female	1.00		
Male	1.13	0.48 – 2.24	0.779
Age			
<13 years	1.00		
13 years	1.32	0.45 – 3.83	0.610
Grade			
8th	1.00		
6th	3.81	0.81 – 17.96	0.090
7th	5.39	1.55 – 18.74	0.008
Believe smokers have more friends			
No	1.00		
Yes	6.93	2.75 – 17.44	<0.001
Owned tobacco-branded item(s)			
No	1.00		
Yes	6.36	2.69 – 15.04	<0.001
Perceive tobacco products to be harmful			
No	1.00		
Yes	0.31	0.11 – 0.88	0.027
Peer or family pressure to use tobacco			
No	1.00		
Yes	2.51	0.87 – 7.30	0.090
Living with a tobacco user(s)			
No	1.00		
Yes	4.67	1.45 – 15.06	0.010
Home smoking rules			
Smoking not allowed	1.00		
Smoking allowed	4.53	1.49 – 13.76	0.008
Smoking restricted	0.79	0.30 – 2.06	0.632
Ever smoked cigarettes			
No	1.00		
Yes	12.54	3.21 – 49.06	<0.001

Note: aOR, adjusted odds ratios; CI, confidence intervals. Bold means significant.