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The Use of E-cigarettes among school-going adolescents in a predominantly rural environment of Central Appalachia

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Abstract

Introduction—E-cigarette use among youth in the United States (U.S.) continues to increase. In the rural Northeast Tennessee, where prevalence of tobacco use is higher than national and state averages, there is no literature on e-cigarette use to inform policies and programs. This study aimed to estimate the prevalence of e-cigarette use and examine association of e-cigarette use with two tobacco products among school-going adolescents.

Method—Data from 894 participants of a school-based survey conducted in 2016 in Northeast Tennessee were analyzed. Descriptive statistics and logistic regression analyses were conducted to estimate the prevalence and delineate the associations between e-cigarette use and other tobacco products.

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Results—Approximately 11% of the participants currently used e-cigarettes, and 35% had ever used e-cigarettes. About 6% of the participants were current users of both e-cigarettes and cigarettes; 4% were current users of e-cigarettes and smokeless tobacco; 3% were current users of all the three products, and 15% had ever tried all the three products. More than one-half of current e-cigarette users (52%) also smoked cigarette. Adjusting for covariates, current e-cigarette use was positively associated with cigarette smoking [Odds Ratio (OR)=27.32, 95% confidence interval (CI)=14.4–51.7] and smokeless tobacco use [OR=7.92, 95% CI=3.8–16.5].

Conclusion—E-cigarette use was more common among the high school students than cigarette and smokeless tobacco use, and a significant proportion of users either smoked cigarettes, used smokeless tobacco, or both. Thus, there is a critical need for preventive policies and programs to address dual and poly-use of these products.

Keywords

E-cigarette; dual use; poly-use; Northeast Tennessee; high school students

INTRODUCTION

Tobacco use in the United States (U.S.) has declined from one in two in the 1950s and 1960s to about one in five in 2014.[1] However, there are disparities in tobacco use across population subgroups and geographic areas, with the highest prevalence in places such as Central Appalachia;[2] hence, *Healthy People 2020's* goal to reduce such disparities.[3] Additionally, there continues to be an uptake in the use of non-tobacco products across all age groups.[1] Particularly, Electronic Nicotine Delivery Systems (ENDS) or electronic cigarettes (e-cigarettes or vape) are the new non-tobacco products that have proliferated in the U.S. and worldwide.[1, 4] Since e-cigarettes entered the U.S. market in 2007,[5] they are increasingly becoming popular among middle and high school students.[6, 7]

Evidence from national data indicates that the prevalence of e-cigarette use among high school students in the U.S. increased from 1.5% in 2011 to 13.4% in 2014.[8] Thus, this increasing usage of e-cigarettes among Middle and High School students has the potential to undermine public health gains of preventing tobacco use among such population.[1, 4] However, research to understand this new phenomenon is sparse both nationally and state-wide and across population subgroups and geographic areas, making it difficult to inform policy, programmatic initiatives, and advocacy.

Although the U.S. Food and Drugs Administration (FDA) has enacted and implemented regulations to address this potential public health threat posed by the increasing e-cigarette use among youths,[9] states across the U.S.,[10] including Tennessee,[11] have enacted some form of e-cigarette policies. These e-cigarette policy, programmatic, and advocacy initiatives have been constrained by the limited scientific evidence on the prevalence, the health impacts on both the user and non-user, and implications for the use of cigarettes and tobacco products.[12, 13] This situation is even worse in places where tobacco use is already higher than the national rate and tobacco control programs are fragile, such as Tennessee.[14] As such, there is a critical need for investigation of e-cigarette use in such environments, providing the basis for this study in Northeast Tennessee, predominantly rural

Central Appalachian part of the state where the population continues to be disproportionately burdened with chronic diseases and high use of tobacco products.[2]

In general, studies on e-cigarettes are limited, but continue to emerge rapidly.[15–17] The evidence from the existing studies have indicated that during 2012–2013, the sale of e-cigarettes in convenience stores in the U.S. increased by 320%, 72%, and 82% for disposable e-cigarettes, starter kits, and cartridges, respectively.[18] Importantly, these studies found that e-cigarette use has been increasing among both adolescents[19] and young adults aged 18–25 years;[20] however, very limited policies and programs exist to address this emerging issue.[10] This situation has generated contentious debates among healthcare and public health professionals.[21–23] While some perceive e-cigarettes as harm reduction devices[24] that can aid smoking cessation,[25–27] others have raised concerns about their safety and likelihood of renormalizing smoking,[28, 29] the potential of introducing nonsmoking youth to nicotine addiction,[19, 30, 31] the use of e-cigarettes as a “gateway” to smoking cigarettes and using other tobacco products,[32, 33] and the potential to undermine smoking cessation and eradicate public health gains over the past half century through “dual use”. [1, 19] Despite the reported increase in usage at the national level,[8] and elsewhere in the U.S.,[34] very limited information is available in Tennessee or Central Appalachia, generating the critical need for this study.

Tennessee has shown some inclinations to control e-cigarette use through the adoption and implementation of a policy in 2015 that prohibits the sale of e-cigarettes to minors aged 18 years and younger; yet, allows e-cigarette use in tobacco-free venues.[11] Tennessee is also known for their high tobacco burden, with a prevalence of tobacco use (cigarettes, smokeless tobacco, and/or cigars) among adolescents exceeding the national prevalence (29.9% vs. 21.4% in youth in 2012).[35] However, there is a near absence of data on e-cigarette use among the youth, although evidence indicates that tobacco use is highly correlated with e-cigarette use.[30, 36] In places such as Northeast Tennessee, there is no data on e-cigarette use among youth, although a recent report suggests high usage in the area.[2] Therefore, this study aimed to estimate the prevalence of and dual use of e-cigarettes with tobacco products and to assess the relationship between e-cigarette use, cigarette smoking, and smokeless tobacco use among high school students in Northeast Tennessee. This study provides information about current use and ever use of three nicotine products (e-cigarettes, cigarettes, and smokeless tobacco) among these adolescents. This is the first major study of e-cigarette use among youth in Northeast Tennessee and the entire state of Tennessee, and one of the major studies in Central Appalachia; therefore, it will serve as a baseline for future research while informing policies and programs pertaining to e-cigarettes and advocacy initiatives.

METHODS

Participants

Data were obtained from the Lunch & Learn Tobacco Use Survey conducted in four high schools in one of the counties in Northeast Tennessee in 2016. As part of the county’s initiative to prevent and control tobacco and e-cigarette use among youth, the Department of Health initiated this school survey to collect data on cigarette smoking, smokeless tobacco

use, and e-cigarette use (vaping). All the high schools in the county were invited to voluntarily participate in the survey with the promise of anonymity and aggregated and de-identified results. Four schools accepted to participate. On the day the survey was administered, all students present at school were eligible to participate in the study. Survey personnel were trained to approach students during their lunchtime and invite them to answer the survey questions. Survey personnel made efforts to ensure high voluntary participation of the students in the survey in order to obtain adequate amount of data to increase the accuracy of estimates from the data.

The Institutional Review Board (IRB) of East Tennessee State University (ETSU) approved this study.

Variables and Measure

The study utilized standard, validated questions adapted from the National Youth Tobacco Survey (NYTS),[37] and the Youth Behavioral Risk Survey (YBRS).[38] The survey questionnaire had 18 questions in total, which were grouped into four sections – “All about you,” “All about smoking,” “All about smokeless tobacco,” and “All about electronic cigarettes and vaping.” Questions were asked of ever use, current use, age of initiation, and intention to quit of these three nicotine products. Additionally, demographic information, albeit limited due to the terms of agreement between the Department of Health and the participating schools, was collected.

Outcome variables

The main outcome variable was current e-cigarette use, which was ascertained using the question, “Do you currently vape?” (Yes/No). Ever use of e-cigarettes was obtained with the question, “Have you ever tried electronic cigarettes/vaping before?” (Yes/No).

Exposure variables

The main independent variables were current smoking (Yes/No) and current smokeless tobacco use (Yes/No), which were ascertained with the questions, “Do you currently smoke?” and “Do you currently use dip/chew?”, respectively. Ever use of e-cigarettes with other tobacco products was assessed using questions on ever use of e-cigarettes (Yes/No) and ever use of smokeless tobacco (Yes/No) or cigarettes (Yes/No). All participants that responded to ever using e-cigarettes and any of the two tobacco products were classified as “Dual ever users”.

Covariates

The covariates for this study were age (categorized into <18 years and ≥ 18 years) and sex because they were the only variables the agreement with the participating schools allowed.

Statistical Analysis

We first conducted descriptive statistics to describe proportions of participants in categories of both outcome and exposure variables. SAS FREQ procedure was used to conduct descriptive statistics of participants, estimate prevalence of current and ever use of e-cigarettes in independent variables, and estimate prevalence of dual and poly-use of e-

cigarettes and the two tobacco products. Chi-square tests were used to assess differences in the estimates by age and sex. To assess the association between current e-cigarette use and exposure variables, we first conducted a simple logistic regression of current e-cigarette use on each exposure variable. A multiple logistic regression model was conducted to examine the association of current e-cigarette use with current cigarette smoking and smokeless tobacco use while controlling for covariates (i.e., age and sex). The significance level was set at 0.05. We reported the odd ratios (ORs) and the associated 95% Confidence Intervals (CI). Data management and all statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Table 1 shows descriptive statistics of the study participants. A total of 894 (57.8% females) participants were included in the analysis. Participants' age ranged from 14 to 22 years (mean=16 years \pm 1.4), with approximately 89% of them under the age of 18 years.

Prevalence of e-cigarette and tobacco products use

Overall, the prevalence of current e-cigarette use was 10.7%. Of the total study participants, 3.6% used e-cigarettes exclusively and 7.2% used e-cigarettes in addition to either cigarettes or smokeless tobacco (data not shown). While 6.4% of females and 16.7% of males were current e-cigarette users, 35.1% (29.0 of females and 43.5% of males) of the participants reported ever using e-cigarettes (Table 2). While 8.1% (4.8% of females and 12.5% of males) and 27.4% (20.5% of females and 36.9% of males) reported that they were current and ever cigarette smokers, respectively, 8.3% (1.4% females and 17.8% males) and 20.3% (7.7% of females and 37.4% of males) were current and ever users of other tobacco products, respectively.

Figures 1 illustrates dual-use and poly-use of e-cigarettes and the two tobacco products. Among e-cigarette users, 52.1% concurrently smoke cigarettes (data not shown). Responses show 5.6% of participants currently used e-cigarettes and cigarettes and 2.8% of participants were current users of e-cigarettes and smokeless tobacco (Figure 1). Also, while 24.3% had ever used e-cigarettes and cigarettes, 16.8% use e-cigarettes and smokeless tobacco products concurrently. The ever use all of the three tobacco products simultaneously (poly-use) was reported by 15% of the participants (ever use data not shown).

Association between e-cigarette use and tobacco products

Table 3 shows the results of simple and multiple logistic regression analyses of the association of current e-cigarette use with current use of cigarettes and smokeless tobacco products. In the bivariate analysis, e-cigarette use was associated with current cigarette smoking (OR=38.33, 95% CI=21.4 – 68.8), current smokeless tobacco use (OR=14.92, 95% CI=8.8 – 25.2) and being male (OR=2.94, 95% CI=1.9 – 4.6). After adjusting for covariates, odds of e-cigarette use were elevated in current smokers (OR=27.32, 95% CI=14.4 – 51.7) and current smokeless tobacco users (OR=7.92, 95% CI=3.8 – 16.5).

Discussion

While the use of tobacco products, particularly cigarette smoking, has continued to decline in the past 50 years,[1] albeit slowly in recent years, there is an increase in e-cigarette use across all demographic groups in the U.S.[1] The increase in the use among youth in particular, has created major public health concerns because research suggests that over 90% of regular tobacco users started using tobacco products before age 18 years.[39] Therefore, there is a potential loss of public health gains in tobacco control in the past half century.[1] The concerns have deepened due to the limited scientific evidence on health impacts of e-cigarettes[12, 13] and near absence of a regulatory framework to protect the public at all levels of governance in the U.S.[40] In this context, this study was conducted to estimate the prevalence of e-cigarette use and to examine the association of e-cigarette use with tobacco products among high school students in a county in Northeast Tennessee, the Central Appalachian part of Tennessee,[2] amidst high level of institutional and social constraints. The study showed that e-cigarette use is more common among the high school students than cigarette smoking and smokeless tobacco use (Table 1). While one in ten (11%) of the students were current e-cigarette users, one in three (36%) reported ever using e-cigarettes. E-cigarettes were concurrently used in conjunction with tobacco products, with one in four and one in five reporting ever use of e-cigarettes with cigarettes, and smokeless tobacco products, respectively. Indeed, the results from this study suggest that e-cigarette use among high school students in this Northeast Tennessee/Central Appalachian county has surpassed tobacco use. These results confirm concerns of public health advocates that e-cigarette has the potential to create new nicotine addicts or renormalize smoking[4, 5] because these e-cigarette users include never users of any tobacco products (4%). Although the scientific evidence on the health impacts of e-cigarette use is still emerging, our findings suggest the need for initiatives to prevent and control non-smoking youth from becoming nicotine addicts through the use of e-cigarettes.

The results from this study showing that e-cigarette use is common among high school students, is consistent with literature.[6, 7] The e-cigarette, by its nature, is portable and convenient to use and has many flavorings and designs[4] that may be more appealing to youth than tobacco products such as cigarettes and smokeless tobacco. The increased use of e-cigarettes among youth may have resulted from an increased awareness of the product through marketing strategies and the lack of policy on public vaping.[41] In Tennessee, where regulatory attempt has been made, the law only restricts the access of youth to e-cigarette products[10] and does not include effective tobacco control policies such as, taxation and banning vaping in public places or advertising.[14] This lack of policy on public vaping or enactment of ineffective policies makes it easier for adolescents to vape freely, unlike cigarettes that have restrictions on where the smoker can smoke.[41] Additionally, the perception of decreased harm associated with e-cigarette use[41] may explain the increasing popularity of the products among adolescents. There is insufficient data on health risks of e-cigarette use and the scientific community is divided on the safety of this product.[41] However, increasing evidence indicates that the use of e-cigarettes could lead to nicotine addiction and subsequent transition to tobacco smoking.[41] In the absence of certainty about health risks, it has been reported that other factors, including social

pressure and marketing, largely affect perception and behavior.[42] This uncertain health risks leaves a large number of youth vulnerable to peer pressure and susceptible to the e-cigarette industry marketing strategy that targets them.[5] This suggests the need for more studies not only to assess the prevalence and the health impacts of e-cigarettes on the user and non-user but also to assess the marketing of this product to youth and the knowledge, attitudes, beliefs, and perceptions of e-cigarette products in population subgroups and geographic areas, similar to this study.

The results of dual use and poly-use of e-cigarettes with tobacco products needs attention because it appears that the use of e-cigarettes poses a threat to tobacco cessation among the study participants. This is because regardless of demographic characteristics (e.g., age and sex), the likelihood of a participant being an e-cigarette user increased by over twenty-six folds and almost seven folds if the person is a current smoker or current smokeless tobacco user, respectively. These results are consistent with the current literature,[30, 36] as previous studies found the use of e-cigarettes to be more common among current and former smokers than nonsmokers.[43] Although there is insufficient evidence on the efficacy of e-cigarette use as a cessation device,[41] some studies have reported that adults use e-cigarettes in an attempt to quit smoking.[44, 45] However, given that our study population consists of youth, it is unlikely that the observed dual use or poly-use reflects an attempt to give up tobacco smoking or smokeless tobacco use. Indeed, an earlier study suggests that the use of e-cigarettes among young student smokers is not motivated by intention to quit smoking,[43] suggesting that this is either a transition phase from e-cigarette use into smoking, or supports the tendency for tobacco users to also use e-cigarettes.[41, 43] The high e-cigarette use prevalence and dual usage highlight the need to implement policies and programs to raise awareness about potential risks. It further suggests the need for more studies to provide evidence to support both regulatory actions and control programs.

Strengths and limitations

This study has limitations that readers should consider when interpreting the results. First, institutional constraints limited our ability to generate a truly representative sample, which made us to resort to convenience sampling approach. While this may likely threaten the generalizability of the study results, this was the best approach to generate data in an environment of institutional and sociocultural impediments to research and add to the emerging literature on e-cigarettes. Second, the study is susceptible to recall and social desirability biases because the data were collected by self-report. However, if these biases occurred, it would rather lead to underestimation of the prevalence of the use of the three nicotine products. Thus, controlling such biases will strengthen, instead of weaken the study results. Third, the results need to be interpreted in the context that the majority of participants were under the age of 18 years. Fourth, due to the agreement between the participating schools and the Department of Health, we could not adjust for school differences, as this information was not available. Similarly, our study could not adjust for other important variables such as peer smoking, parental smoking and family socio-economic status that likely affect tobacco use behavior due to the institutional constraints. In spite of these limitations, this study provides major insights into e-cigarettes use in

Northeast Tennessee/Central Appalachia that can inform statewide and national policies on e-cigarettes. Our sample is relatively large, hence, the study is statistically powered.

Conclusion

The paucity of research on e-cigarettes, amidst policy stasis in the U.S. across all levels of governance, provided rationale for this study in a research vacuum and policy-challenged environment of Northeast Tennessee. It was found that e-cigarette use among high school students has surpassed cigarette smoking and the use of smokeless tobacco products. Additionally, dual use and poly-use of tobacco were high among e-cigarette users, accounting for a strong association between e-cigarette use and cigarettes smoking and the use of smokeless tobacco products. While these results suggest the need for more studies to assess the impact of e-cigarettes on the health of the users and non-users, the high prevalence of e-cigarette use and the significant association between e-cigarette use and tobacco products suggest a critical need for preventive policies and programs to address this emerging public health issue locally, statewide, and nationally.

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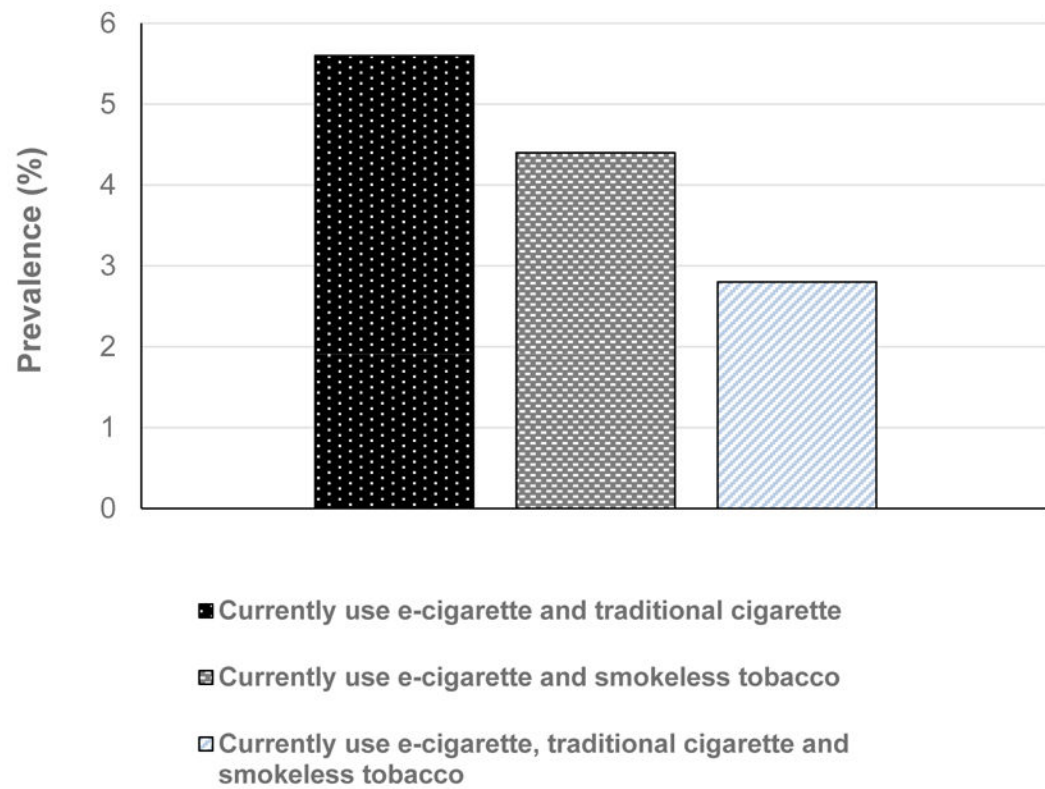


Figure 1. Current use of e-cigarette and tobacco products

Data source: Lunch & Learn Tobacco Use Survey, 2016, conducted in four high schools in Northeast Tennessee

Table 1

Characteristics of study participants (N=894)

Variable	2016 Survey % (n)
Sex	
Female	57.8 (517)
Male	42.2 (377)
Age	
<18 years	88.8 (794)
18 years	11.2 (100)
Currently use e-cigarette	
No	89.3 (798)
Yes	10.7 (96)
Currently smoke cigarette	
No	91.9 (822)
Yes	8.1 (72)
Currently use smokeless tobacco	
No	91.7 (820)
Yes	8.3 (74)
Ever used e-cigarette	
No	64.9 (580)
Yes	35.1 (314)
Ever smoked cigarette	
No	72.6 (649)
Yes	27.4 (245)
Ever used smokeless tobacco	
No	79.8 (713)
Yes	20.4 (181)
Total	100.0 (894)

Data source: Lunch & Learn Tobacco Use Survey, 2016, conducted in four high schools in Northeast Tennessee.

Table 2

Prevalence of current and ever use of e-cigarette by sex and age (N=894)

Variable	Currently use e-cigarette %	Ever used e-cigarette %
Sex		
Female	6.4 ***	29.0 ***
Male	16.7	43.5
Age		
<18 years	10.5	33.5 **
18 years	13.0	48.0
Overall	10.7	35.1

Note:

**
p<0.01;***
p<0.001. P-values are based on Chi-square tests.

Data source: Lunch & Learn Tobacco Use Survey, 2016, conducted in four high schools in Northeast Tennessee

Table 3

Association between current e-cigarette use and current cigarette smoking/smokeless tobacco use (N=894)

Variable	Unadjusted OR	95% CI	Adjusted OR	95% CI
Currently smoke cigarette				
No	1.00		1.00	
Yes	38.33 ^{***}	21.4 – 68.7	27.32 ^{***}	14.6 – 51.2
Currently use smokeless tobacco				
No	1.00		1.00	
Yes	14.92 ^{***}	8.8 – 25.3	7.92 ^{***}	3.9 – 16.2
Sex				
Female	1.00		1.00	
Male	2.94 ^{***}	1.9 – 4.6	1.38	0.8 – 2.5
Age				
<18 years	1.00		1.00	
18 years	1.28	0.7 – 2.4	0.95	0.4 – 2.1

Abbreviations: OR, Odds ratio; CI, Confidence interval

Notes:

*
p<0.05;**
p<0.01;***
p<0.001. Estimates were derived from logistic regression models.

Data source: Lunch & Learn Tobacco Use Survey, 2016, conducted in four high schools in Northeast Tennessee