



Social media and use of electronic nicotine delivery systems among school-going adolescents in a rural distressed Appalachian community

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ABSTRACT

Electronic nicotine delivery systems (ENDS) are the most used tobacco products among middle and high schoolers in the United States (U.S.). Familial relations and access play a major role in uptake among adolescents; yet the role of social media in this phenomenon in the context of communities impacted by tobacco-related health disparities is understudied. In Spring 2019, data were collected from adolescents in 8th and 9th grades in a school located in a rural distressed county in Tennessee to assess social media's role in ENDS uptake. Descriptive and multivariable statistical analyses were performed to delineate factors associated with ENDS use. Of a total of 399 respondents, 12.5 % reported current ENDS use and 22.1 % indicated having ever discussed ENDS on social media. Closed messaging platforms (Snapchat) and video platforms (Facebook/Instagram/YouTube) were the most reported form of social media used (8.31 % and 8.31 % respectively). Social media use was positively associated with both ever ENDS use (odds ratio [OR] = 2.9) and current ENDS use (OR = 3.98). Parental advice against ENDS use was positively associated with ever ENDS use. In conclusion, social media use was positively associated with both ever and current ENDS use, and Snapchat was the most popular platform among this population of students. The results indicate that youth social media engagement may lead to exposure that can influence ENDS uptake. Future studies are needed to further examine these associations among distressed communities.

1. Introduction

Electronic Nicotine Delivery Systems (ENDS) use is harmful to youth due to adverse effects of nicotine exposure on brain development (U.S. Department of Health and Human Services, 2016; U.S. Department of Health and Human Services, 2020; U.S. Department of Health and Human Services, 2014) and can lead to co-use or transition to more harmful conventional tobacco products (CTPs) (Barrington-Trimis et al., 2016; Goldenson et al., 2017; Primack et al.; Unger et al., 2016) and other forms of substance use. (Seaman et al., 2020; Smith et al.) In high-risk environments for tobacco use (Truth Initiative, 2019, 2020; American Lung Association, 2016) such as Central Appalachia, research on patterns of ENDS use and associated social risk factors is just emerging.

(Hart et al., 2018; Mamudu et al., 2020, 2022, Mattingly et al., 2020b,a) Further, despite increased uptake, regulation of ENDS marketing and access remains uneven. (Mamudu et al., 2019) Although federal legislation has increased the minimum legal sales age to 21 years (United States Congress, 2020) and the U.S. Food and Drug Administration (FDA) prohibits certain unauthorized flavored ENDS products, (Food and Drug Administration, 2021) the need for research to inform future public health initiatives is urgent, especially as the FDA has for the first time permitted the sale of certain e-cigarette products on the U.S. market. (Food and Drug Administration, 2021).

The rise in popularity of ENDS coincides with higher levels of engagement with social media platforms among adolescents. (Cullen et al., 2019; Gentzke et al., 2019; Emery et al., 2014; Cavazos-Rehg

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et al., 2021; Donaldson et al., July 2022) In this regard, it has been found that the exposure to ENDS-related information was associated with the use of social media. (Emery et al., 2014) While these platforms may be used for tobacco counter-messaging and health promotion efforts, they can also facilitate pro-tobacco dialogue, marketing, and information exchange. (Chu et al., 2015) Two factors that influence tobacco use, marketing (National Cancer Institute, 2008) and peer group social influences, (U.S. Department of Health and Human Services, 2016) are readily conveyed through social media, directly impacting adolescents. A recent review found that social media is an increasingly popular medium for ENDS marketing, (Collins et al., 2018) and social media promotions often emphasize ENDS safety compared to cigarettes, efficacy for smoking cessation, and utility in avoiding smoking prohibitions. (McCausland et al., 2019).

Despite the ubiquity of social media among adolescents, (Pew Research Center, 2018; Clinic, 2019) there is limited knowledge about social media use patterns among adolescent ENDS users, particularly involving those residing in rural areas. This lack of data extends to patterns of ENDS use among specific populations; one study using 2013–2014 data from the Population Assessment of Tobacco and Health (PATH) found that while cigarette and smokeless tobacco use were more prevalent in rural than urban areas, no rural–urban differences existed in ENDS use, although dual- and poly-use of tobacco products was higher in urban areas. (Roberts et al., 2017) In another study, researchers found that urban adolescent cigarette smokers were 86 % more likely than rural students to also use ENDS. (Noland et al., 2018).

Widespread use of social media among adolescents (95 % have access to a smartphone, nearly 90 % go online multiple times a day, and 97 % use popular social media platforms^{31,32}) coupled with limited research involving rural populations provides an opportunity to understand the relationship between social media and ENDS use among these vulnerable communities of users. This study examines the association between social media and ENDS use patterns among school-going adolescents in a rural distressed county in Appalachian Tennessee. (Economic Innovation Group (EIG), 2020; Parker et al., 2018) Appalachian youth reside in a high-risk environment for tobacco use due to disproportionately high prevalence of tobacco use, a history of tobacco cultivation and production, a socially and culturally receptive environment to tobacco use, (Association, 2016; Beaver, 1988; Keefe, 2005) and weak tobacco control policies and programs. (Initiative, 2019; Initiative, 2020) Complicating this situation, evidence indicates that ENDS act as a “gateway” to CTP use among youth. (Barrington-Trimis et al., 2016; Leventhal et al., 2016; Primack et al.; U.S. Department of Health and Human Services, 2016) As such, addressing ENDS use, particularly in this setting, has direct implications for preventing CTP use.

2. Methods

2.1. Study setting and population

The study population comprises adolescents in 8th and 9th grades in a school located in an Appalachian Regional Commission (ARC)-designated rural distressed county in Appalachian Tennessee. (Economic Innovation Group (EIG), 2020; Parker et al., 2018) The school administration, along with the County and Regional health departments, collaborated with the study team to administer an online survey conducted in March/April 2019, collecting data on prevalence, knowledge, opinions, and perceptions of tobacco products use, including ENDS, as well as questions about social media use and exposure to tobacco and ENDS content on these platforms. A passive consent procedure was used to obtain parental /guardian/caregiver consent and in compliance with the Helsinki Declaration. (The World Medical Association WMA, 1964) Adolescent participants were given the opportunity to voluntarily assent to study participation and informed that they could withdraw at any time without repercussions. As part of the agreement between the health department, the school administration, and the parents' association, the

survey questionnaire contained limited demographic questions ensuring participant anonymity. This community-based collaborative approach involving health departments, school administration, and parents' association culminated in a 92 % response rate. The de-identified survey data file was sent to the investigators for analysis and reporting of results. The Institutional Review Board of East Tennessee State University (ETSU) exempted the analysis of the de-identified data for publication.

2.2. Outcome variable

The primary outcome variables assessed in this study were ever and current ENDS use. At the time this study was conducted, JUUL was the most used ENDS brand in the U.S., accounting for over 50% of the market share as of 2019, was included in the question because emerging reports suggest that youth do not usually consider JUUL as an e-cigarette or vaping activity (commonly associated with vaping). (Hammond et al., 2018; Jackler and Ramamurthi, 2019) As such, ENDS in this study includes e-cigarettes and JUUL, as described by the FDA. (U.S. Food and Drug Administration, 2016; Food and Drug Administration FDA., 2020; Food and Drug Administration, 2020b).

Ever ENDS use was measured with the question “Have you ever tried electronic cigarettes, including JUUL, even just one or two puffs?” (Yes/No), while current ENDS use was ascertained with two questions: (1) “During the past 30 days, how many days did you use the following tobacco products? (List of products adapted from the NYTS, (Wang et al., 2019, 2020; U.S. Department of Health and Human Services, 2016) the U.S. Centers for Disease Control and Prevention (CDC) and the FDA, (U.S. Food and Drug Administration, 2016; Food and Drug Administration FDA., 2020; Food and Drug Administration, 2020b) including JUUL);” and (2) “During the past 30 days, how many days did you use the products in the previous question: please list the product and number of days.” Responses to these two questions were combined to identify current ENDS users in our study population. Ever and current ENDS use were measured as binary variables: “0” for “No” and “1” for “Yes”. For ever ENDS use, the categorization was binary: never ENDS use and ever used ENDS, with the never ENDS use as the reference category. For current ENDS use, the categorization was also binary: current ENDS use, and not current ENDS use with the not current ENDS use as the reference category. The never ENDS use category included never used ENDS at any time in their lives and the ever ENDS use category includes those who have ever used ENDS at any time in their lives but have not used it in the 30 days preceding the survey, while current ENDS use includes those who have used ENDS in the 30 days preceding the survey irrespective of whether they used it for the first time before or during the 30 days preceding the survey.

2.3. Exposure variable

Use of social media to talk about e-cigarettes and social media platform used to talk about ENDS were the exposure variables used in this study. The primary purpose of examining this exposure variable was to assess if respondents who were more actively sharing, interacting, and participating on social media platforms had behavior related to higher ever or current ENDS use and if social media use is relevant to the risk environment for these populations. To assess for social media use by study participants in discussing ENDS products, we utilized the question (1) “Do you use social media to talk about (you can choose more than one)? (Tobacco products; Electronic cigarettes, or vaping; JUUL; Other Nicotine products; Does not apply).” The variable was recoded as “No” (Does not apply, Tobacco products, other nicotine products) and “Yes” (Electronic cigarette products, JUUL).

We also used the question: “What type of social media do you use to talk about electronic cigarettes and JUUL?” to ascertain the type of social media used by study participants to discuss ENDS use. The variable was recoded as (1) predominantly image and video platforms (“YouTube/Instagram/Facebook” which are primarily video, picture and

multimedia sharing platforms and are generally popular among adolescents), (2) Open messaging platforms (Reddit, Twitter, and Others, these are primarily news and microblogging platforms where the youth adoption is lower compared to other platforms), (3) Closed messaging platforms (Snapchat which is a closed messaging platform with limited access for people outside the chat group, provides confidentiality/secretcy among users and enjoys a high volume of youth users and growing popularity. It provides distinctly different services than categories 1 and 2 above). Types of social media were stratified in these three groups to determine if the overall popularity of a platform among this age demographic had an impact on tobacco and ENDS behavior.

2.4. Covariates

Covariates includes sex, school grade level of participants, perception of tobacco products as dangerous, ease of access to tobacco products, and parental/guardian advise against tobacco use (including ENDS). Female was coded as the reference category for sex. Perception of danger of all tobacco products was ascertained with "How strongly do you agree or disagree with the statement: "All tobacco products are dangerous" with Likert-scale responses varying from strongly disagree to strongly agree. The variable was further recoded as "agree" (strongly agree, agree) or "disagree" (strongly disagree, disagree) and agree was used as the reference category. Access to tobacco products was ascertained with "How easy would it be for you to get tobacco products (including ENDS) if you wanted them?" The responses were "very easy", "somewhat easy", and "not easy". These responses were recoded as "Not easy at all" and "Easy" ("very easy" + "somewhat easy"), and "Not easy at all" was used as the reference category. Parental/guardian advice against tobacco use was ascertained with "During the past 12 months, did your parents or guardians talk to you, even for once, about not using any type of tobacco products (including ENDS)?" and the answers were "No" or "Yes" with "No" as the reference category.

2.5. Statistical analysis

Descriptive analyses (frequencies, percentages) were used to examine the prevalence of ever and current ENDS use. The bivariate associations between each outcome variable and each exposure variable (i.e., use of social media and type of social media used) as well as all the covariates were analyzed using Pearson's chi-square test. To identify multicollinearity, we conducted data diagnostics with the multiple linear regression method that included age and grade level at school, with evidence of multicollinearity between age and grade based on the value of Variance Inflation Factor > 10 and Tolerance < 0.1. As such, we dropped age and used grade because of its categorical nature, which fits well into our logistic regression analysis model. We then used the multinomial logistic regression analyses to determine the associations of the exposure variable (Use of Social Media Platforms) with the outcome variable after adjusting for the covariates. A $p \leq 0.05$ was considered statistically significant. The adjusted odds ratios (ORs) and the associated 95 % confidence intervals (CIs) are reported. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

3. Results

3.1. Characteristics of the study population

Study population characteristics are shown in Table 1. A total of 399 students participated in the study, 22.06 % of whom used social media to talk about ENDS. Of all the participating students, 27.1 % reported that they were ever ENDS users while 12.5 % indicated that they were current ENDS users. Fifty-two percent were females, 50.43 % were in the 8th grade, and 49.57 % were in the 9th grade. While 75.8 % of the students perceived that the use of all tobacco products (including ENDS) was dangerous to health, 61.8 % reported that access to ENDS was easy. Fifty-one percent of the students reported that they had received advice from parent /guardian not to use any tobacco product. Overall, 72.9 %

Table 1
Characteristics of Study Participants (N = 399).

Variable	Total (N)	Proportion of Total (%)	Ever ENDS Use (%)	Chi-square P value	Current ENDS Use (%)	Chi-square P value
Use of social media to talk about ENDS:						
No	272	77.94	63 (58.3)	<0.0001	23 (46.0)	<0.0001
Yes	77	22.06	45 (41.7)		27 (54.0)	
Types of social media used by participants:						
None						
Open Messaging (Reddit/Twitter/Other)	272	77.94	63 (58.3)	<0.0001	23 (46.0)	<0.0001
Video (Facebook/Instagram/You Tube)	19	5.44	10 (9.3)		02 (4.0)	
Closed Messaging (Snapchat)	29	8.31	14 (12.9)		08 (16.0)	
	29	8.31	21 (19.4)		17 (34.0)	
Current Grade in School:						
8th grade	177	50.43	41 (37.9)	0.0016	15 (30.0)	0.0007
9th grade	174	49.57	67 (62.1)		35 (70.0)	
Sex:						
Female	185	52.71	61 (56.5)	0.3642	30 (60.0)	0.2937
Male	166	47.29	47 (43.5)		20 (40.0)	
Perceive tobacco products as dangerous:						
Agree	266	75.78	73 (67.6)	<0.0179	37 (74.0)	0.7010
Disagree	85	24.22	35 (32.4)		13 (26.0)	
Believes ENDS are easy to obtain:						
Not easy at all	134	38.18	21 (19.4)	<0.0001	6 (12.0)	<0.0001
Easy to obtain	217	61.82	87 (80.6)		44 (88.0)	
Parental/Guardian advise against tobacco:						
No	172	49.0	49 (45.4)	0.3456	24 (48.0)	0.9304
Yes	179	51.0	59 (54.6)		26 (52.0)	

of the students reported that they had never used any tobacco product. Nearly 42.0 % of participants who have ever used ENDS also used social media to discuss ENDS while 58.3 % of all participants who have ever used ENDS do not discuss ENDS on social media. Thirty-seven percent of all participants who have ever used ENDS were in 8th grade, with the remaining in 9th grade. Over two-thirds (67.6 %) of participants who have ever used ENDS perceived tobacco products as dangerous to health, while 80.6 % said they could easily obtain ENDS. Among participants who currently use ENDS, 54.0 % discussed ENDS in social media, 70.0 % were in 9th grade, 60.0 % percent were females, 74.0 % perceived the use of tobacco products as dangerous to health, and about 88.0 % of them reported that it was easy to obtain ENDS. The predominant social media platforms used by respondents reporting use of social media to talk about ENDS were image/video-based platforms (8.3 %), open messaging (5.4 %), and closed messaging (8.3 %). Approximately 78.0 % of participants do not use social media to talk about ENDS.

3.2. Bivariate association between social media and ENDS use

Participants who used social media to talk about ENDS were found to have increased odds of lifetime ENDS use (OR = 4.82; CI = 2.81 – 8.24, $p < 0.0001$) compared to those who did not use social media to talk

Table 2
Bivariate Association between Social Media Use and ENDS Use among school-going youths in rural Appalachia (N = 399).

Variable	Ever ENDS Use			Current ENDS Use		
	OR	CI	p value	OR	CI	p value
Use of social media to talk about ENDS:						
No	4.82	2.81–8.24	<0.0001	6.62	3.47 – 12.64	<0.0001
Yes						
Types of social media used by participants:						
Videos	1.11	0.35 –	0.4837	0.38	0.07 –	0.0914
(Facebook/Instagram/YouTube)	2.63	3.57 –	0.0742	6.38	2.03 –	0.0002
Open Messaging (Reddit/Twitter/Other)		0.87 –			1.92 –	
Closed Messaging (Snapchat)		7.89			21.15	
Current Grade in School:						
8th grade	2.10	1.32 –	0.0018	2.95	1.54 –	0.0011
9th grade		3.34			5.65	
Sex:						
Female						
Male	0.81	0.51 –	0.3645	0.72	0.39 –	0.2951
		1.28			1.33	
Perceive tobacco products as dangerous:						
Agree	1.84	1.12 –	0.0188	1.15	0.57 –	0.7011
Disagree		3.06			2.28	
Believes ENDS are easy to obtain:						
Not easy at all	3.63	2.12 –	<0.0001	5.71	2.36 –	0.0001
Easy to obtain		6.22			13.83	
Parental/Guardian advise against tobacco:						
No	1.25	0.79 –	0.3460	0.97	0.53 –	0.9304
Yes		1.96			1.78	

OR – Odds Ratio
CI – Confidence Intervals

about ENDS (Table 2). Also, participants who used social media reported higher odds for current ENDS use (OR = 6.62; CI = 3.47 – 12.64, <0.0001). Compared to open image/video platforms, participants who used closed messaging platforms reported higher odds of current ENDS use (OR = 6.38; CI = 2.81 – 8.24, $p < 0.0001$), while there was no statistically significant difference in the association between current use of ENDS and the use of open messaging platforms (Reddit/Twitter/Other) compared to open image/video platforms.

In relation to participant grade, ease of access to ENDS, sex, and parental advice, participants in 9th grade reported higher odds of lifetime ENDS (OR = 2.10; CI = 1.32 – 3.34, $p < 0.0001$) and current ENDS (OR = 2.95; CI = 1.54 – 5.65, $p < 0.0001$) use compared to 8th graders. Study participants who did not perceive tobacco products as dangerous to health had 1.98 higher odds (CI = 1.12 – 3.06) to have ever used ENDS. Participants who believed it was easy to obtain tobacco products reported higher odds of lifetime ENDS (OR = 3.63; CI = 2.12 – 6.22, $p < 0.0001$) and current ENDS (OR = 2.95; CI = 1.54 – 5.65, $p < 0.0001$) use compared to their counterparts who found it difficult to obtain ENDS products. There was no statistically significant association between sex and having ever used ENDS (OR = 0.81, CI = 0.51 – 1.28, $p = 0.3645$) or sex and being a current user of ENDS (OR = 0.721, CI = 0.39 – 1.33, $p = 0.7011$). Likewise, there is no statistically significant association between parental advice against the use of tobacco products and having ever used tobacco.

3.3. Multivariable association between social media and ENDS use and analysis of other covariates

There was a significant positive association between social media use to talk about ENDS and current ENDS use among those who were active on these platforms (Table 3). Individuals who use social media to talk about ENDS reported higher odds of lifetime ENDS (OR = 2.90; CI = 1.22 – 5.65, $p = 0.0163$) and current ENDS (OR = 3.98; CI = 1.47 – 10.82, $p = 0.0067$) use.. Compared to participants who used image and video-based platforms to discuss ENDS, those who used open messaging platforms had no significant difference in the odds of ever ENDS use. Those who used closed messaging platforms also had no significant difference in the odds of having ever used ENDS compared to those who used predominantly open image and video-based platforms. However, compared to participants who used image and video platforms, those who used closed messaging platforms reported higher odds of current ENDS use (OR = 6.11; CI = 1.65 – 22.66, $p = 0.0088$),

Significant results were observed among the covariates. Ninth graders reported higher odds of lifetime ENDS use (OR = 1.91; CI = 1.14 – 3.22, $p = 0.145$), and current ENDS use. (OR = 2.76; CI = 1.29 – 5.89, $p = 0.0088$), compared to eighth graders.. Perception of tobacco products as dangerous was only significantly associated with the ever ENDS users compared to the never ENDS users (OR = 1.98, CI = 1.1 – 3.6, $p = 0.0253$), while parental/guardian advise against tobacco use was also significantly associated with the ever ENDS use compared to the never ENDS use (OR = 1.8, CI = 1.1 – 3.1, $p = 0.0294$). Those who reported that it was easy to obtain ENDS had a 3.4 higher odds of having ever used ENDS (CI = 1.86 – 6.03, $p < 0.0001$) compared to the never ENDS users, and 4.3 higher odds of being current ENDS users (CI = 1.66 – 11.18, $p = 0.0027$) compared to those who were not current ENDS users. There was no statistically significant association between sex of participants and the odds of having ever used ENDS or being a current ENDS user.

4. Discussion

The use of social media has become ubiquitous among adolescents in the U.S. (Pew Research Center, 2018; Mayo Clinic, 2019) Although prior studies have examined engagement with social media and tobacco and nicotine use behavior, few of these studies have focused on rural populations or students using a community-based collaborative approach.

Table 3
Multivariable Association between Social Media Use and ENDS Use among school-going youths in rural Appalachia (N = 399).

Variable	Ever Ends Use			Current ENDS Use		
	OR	CI	p value	OR	CI	p value
Use of social media to talk about ENDS:						
No	2.90	1.22 – 6.91	0.0163	3.98	1.47 – 10.82	0.0067
Yes						
Types of social media used by participants:						
Videos (Facebook/Instagram/YouTube)	1.19	0.34 – 4.23	0.7855	0.35	0.06 – 2.09	0.2497
Open Messaging (Reddit/Twitter/Other)	2.48	0.76 – 8.14	0.1336	6.11	1.65 – 22.66	0.0067
Closed Messaging (Snapchat)						
Current Grade in School:						
8th grade	1.91	1.14 – 3.22	0.0145	2.76	1.29 – 5.89	0.0088
9th grade						
Sex:						
Female						
Male	0.84	0.51 – 1.41	0.5190	0.93	0.45 – 1.91	0.8486
Perceive tobacco products as dangerous:						
Agree	1.98	1.09 – 3.61	0.0253	0.95	0.41 – 2.22	0.9121
Disagree						
Believes ENDS are easy to obtain:						
Not easy at all	3.35	1.86 – 6.03	<0.0001	4.31	1.66 – 11.18	0.0027
Easy to obtain						
Parental/Guardian advise against tobacco:						
No	1.8	1.06 – 3.06	0.0294	1.14	0.55 – 2.36	0.7264
Yes						

OR – Odds Ratio
CI – Confidence Interval
Bolded: Significant results

The studies looking at the possible interaction between social media and tobacco use behavior have primarily focused on analyzing data on adolescents from the PATH study and other panel data, as well as examining the effect of exposure to tobacco content on social media, but rarely among rural groups. (Emery et al., 2014; Cavazos-Rehg et al., 2021; Donaldson et al., 2022) This study sought to characterize the relationship between ENDS behavior among adolescents residing in a rural area and ENDS-related social media use. From a baseline perspective, nearly 1 in 3 (27.1 %) and 1 in 8 (12.5 %) of adolescents in this study reported having ever used ENDS and being a current ENDS user, respectively. Over 1 in 5 (22.1 %) participants reported using social media to talk about ENDS.

Greater use and reliance on social media platforms as peer influence and information sources has the potential to contribute to ENDS susceptibility, uptake, and risk perception among adolescents who are active in discussing ENDS topics on different social media platforms. In this study, the use of social media to discuss ENDS was significantly associated with increased current and ever ENDS use by about 4 and 3 times, respectively. Although these results are exploratory, they are consistent with studies that have similarly characterized the role of social media as a venue for ENDS marketing and promotions. (Mamudu et al., 2019; U.S. Department of Health and Human Services, 2016)

Adolescents may be exposed to pro-ENDS messages that are organic and originate through user-generated comments and interactions that may be influencing if coming from known network peers. (Amin et al., 2020 Jan) Thus, the nature of social media engagement to discuss ENDS and the relative impact of different platform information delivery approaches and content types (e.g., open platforms for sharing media versus microblogging platforms and closed messaging platforms) will be important to ascertain in future studies. With ENDS not included in the Master Settlement Agreement, (National Association of Attorneys, 1998) public health efforts to prevent the initiation and continuation of ENDS use should incorporate design of future digital media interventions and regulation of online advertising, sellers, and means of underage exposure and access via social media.

It has also been established that the initiation of all nicotine products, including ENDS, begins during adolescence. (U.S. Department of Health and Human Services, 2016) In this study, the participants were within the adolescence age-range with all participants either an 8th (middle school) or 9th grade (high school), with the 9th graders having higher odds of being either a current ENDS user or having ever used ENDS compared to the 8th graders. In the 2019 NTYS, which coincided with this study, the prevalence of ENDS use was 10.5 % among middle school students and 27.5 % among high school students. (Wang et al., 2019) Coupling these NYTS results with this study indicates that the progression from middle school to high school years results in greater ENDS use and is a critical phase for intervention to prevent the initiation of ENDS. Thus, there is the need for further research to better understand and identify drivers of how age of tobacco use initiation and changing school contexts (i.e., middle school versus high school) contributes to ENDS use among adolescents, especially those in high-risk communities10, (Truth Initiative, 2019) such as the Central Appalachian region. (Mamudu et al., 2019) Understanding what makes youth susceptible to ENDS use during this critical transitional phase of adolescence could contribute to effective interventions that address the increasing trend of ENDS use with age.

This study has certain limitations. It is correlational and cannot establish what causes ENDS use. We are unable to determine whether the exposure came before the outcome or vice versa; therefore, temporal relationship between the exposure and the outcome cannot be ascertained. Further studies, perhaps more longitudinal in design, should consider factors that may be linked to ENDS use. The information in the study was collected via self-report, which is subject to recall and social desirability biases, which could have led to an underestimation of the extent of ENDS use in this population. The study is limited in generalizability because results cannot be discussed outside of the Appalachian context, which would prevent the findings to be used to contextualize the relationships within other rural, socioeconomically depressed areas in the U.S. Despite these limitations, to our knowledge, this study is the first to capture associations between social media and ENDS use among adolescents at an enhanced risk to use ENDS products. As such, this research provides a foundation for larger studies to understand the phenomenon and to develop the appropriate social media interventions.

Declaration of Competing Interest

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

Data availability

Data will be made available on request.

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