ELECTRONIC NICOTINE DELIVERY SYSTEMS

USE AND ADVERTISING AMONG

ADOLESCENT AMERICANS

by

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ABSTRACT

Throughout the last decade, adolescent use of electronic nicotine delivery systems (ENDS) has increased significantly. The products are not subject to nearly the same regulations or advertising restrictions as traditional cigarettes. The purpose of this research was to investigate the association between exposure to several channels of e-cigarette advertisement and adolescent use of the products. Secondary data were obtained from the 2019 National Youth Tobacco Survey (N = 18000), which gathered information from students in grades 6 through 12. Four channels of e-cigarette advertisements were identified (Internet, print, retail, and TV) and exposure was measured using five response options: never, rarely, sometimes, most of the time, and always. Separate logistic regression models were employed to assess the relationship between e-cigarette advertising and ENDS use, adjusting for age, gender, school level, ethnicity, and race. A subgroup analysis of age was included to assess how use of ENDS by advertisement exposure may differ between three distinct age ranges (11–13, 14–15, and 16–18). The findings indicate a significant association between exposure to e-cigarette advertisements and ENDS use by adolescents in the United States. Among all age groups, print advertisements are less correlated to ENDS use than the other advertisement channels. Findings suggest that early-adolescents (11–13) have the highest odds of ENDS use, particularly in relation to Internet and retail advertisement channels. Future longitudinal studies are needed to investigate whether a causal relationship between advertising and ENDS use exists. Given the harmful health impacts linked to nicotine use and the unknown impacts of ENDS, strategic prevention and control measures are needed to protect vulnerable populations such as adolescents.

DEDICATION

This work is dedicated to my father, mother, and stepfather, Joey Cochran, Jill Smith, and Glenn Smith, without whom I would be significantly less curious, motivated, supported, and encouraged.

LIST OF ABBREVIATIONS

CDC	Centers for Disease Control and Prevention
ENDS	Electronic Nicotine Delivery Systems
NYTS	National Youth Tobacco Survey
PSA	Public Service Announcement

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1. INTRODUCTION

Although overall tobacco use in the United States has been steadily declining for several decades, the uptake of electronic nicotine delivery systems (ENDS) is on the rise among adolescents and young adults. Since 2014, ENDS, a non-combustible tobacco product also referred to as a vaporizer, e-cigarette, or vape pen, are the most common form of tobacco use among adolescents (Cullen et al., 2019; Wang et al., 2019). Most tobacco product use is initiated in adolescence (U.S. Department of Health and Human Services, 2012). An estimated 3.6 million middle and high school students in the United States are current e-cigarette users, having used ENDS within the last 30 days (U.S. Food and Drug Administration, 2020a). Adolescents are particularly susceptible to advertisements (Calvert, 2008), which may influence initial take up and consumption decisions (Kwon et al., 2018). As ENDS use grows, it is crucial for researchers to understand who uses these products and what factors contribute to widespread use.

Consisting of an energy source (e.g., battery), a heating mechanism, and a cartridge or reservoir that contains nicotine and flavored e-liquid, ENDS vaporize the liquid and the vapor is then inhaled into the lungs (U.S. Food and Drug Administration, 2020b). Although ENDS do not contain tobacco, they do contain nicotine, which has been linked to lung inflammation and disease (Drope et al., 2017). Recent research has shown that nicotine exposure to the adolescent brain can result in lasting negative effects on memory, cognition, and attention-span (England et al., 2015; U.S. Department of Health and Human Services, 2016; Yuan et al., 2015). E-liquids and aerosols contain harmful chemicals (Cheng, 2014) and carcinogens (Kosmider et al., 2014;

National Institute on Drug Abuse, 2020). Additionally, most ENDS are designed to resemble pens or USB flash drives, with sleek, discreet designs that allow usage to go undetected in many public settings, where cigarette smoking is typically banned (National Institute on Drug Abuse, 2020).

The highly addictive nicotine in ENDS contributes to the initiation or continuation of use among adolescents (Drope et al., 2017). Kwon et al. (2018) found that individuals who had ever-used alcohol, marijuana, or other substances are considered more at-risk to initiate e-cigarette use compared to those who had never used any substance. Adolescents may begin use depending on the influence of their peers (Padon et al., 2018). Many also initiate ENDS use holding the belief that ENDS are better for their health than traditional tobacco products, such as cigarettes or cigars, despite no evidence to support that claim (Coleman et al., 2016; Tan et al., 2016).

The Tobacco Control Act of 2009 bans the sale of combustible tobacco products to minors (U.S. Food and Drug Administration, 2020c). In 2019, the minimum legal age to purchase tobacco products, including e-cigarettes, was raised from 18 to 21 (Centers for Disease Control and Prevention, 2020). However, ENDS use continues to increase in the United States, particularly among adolescents (Cullen et al., 2019; Evans-Polce et al., 2020; Glasser et al., 2017; Wang et al., 2019). Advertisements through several channels have been linked to adolescent consumption of ENDS (Collins et al., 2019; Hansen et al., 2020; Mantey et al., 2016; Padon et al., 2018; Pike et al., 2019; Singh et al., 2016). Adolescents are also a vulnerable population more susceptible to advertisements through social media, television, and the Internet (Calvert, 2008; Grier & Kumanyika, 2010). Therefore, illegal consumption of ENDS by adolescents is a critical matter, especially given the harmful nature of nicotine (Yuan et al., 2015) and the potential role of advertisements (Lovato et al., 2011).

This study aimed to investigate the relationship between advertising and adolescent ENDS consumption in the United States, using the 2019 National Youth Tobacco Survey (NYTS). The Centers for Disease Control and Prevention (CDC) conducts this nationally-representative survey annually to collect information on tobacco use among youth, primarily aged 11 to 18. This study assessed the relationship between different channels of advertising, including Internet, print, retail, and TV, and ENDS use among adolescents. Following similar studies, it was hypothesized that there will be a positive association between e-cigarette advertisement exposure and ENDS use (Mantey et al., 2016; Singh et al., 2016). Given the limited research on this topic, this analysis aimed to inform policy and regulations on product advertisements aimed at vulnerable populations.

2. LITERATURE REVIEW

A. ENDS INITIATION, USE, AND PERCEPTIONS

The age of initiation for adolescent ENDS users is declining (Evans-Polce et al., 2020) while access to ENDS is growing (Pepper et al., 2019). Initiation of ENDS use by age 14 rose from 9% in 2014 to 29% in 2018 (Evans-Polce et al., 2020). Researchers have found that 27.5% of high school students and 10.5% of middle school students are current e-cigarette users (Cullen et al., 2019). Roughly 55% of high schoolers and nearly 27% of middle schoolers are "daily users" or "frequent users" of ENDS, reporting use on at least 20 of the previous 30 days (Cullen et al., 2019; Pepper et al., 2019). Over half of all adolescent ENDS users reported initiating use out of curiosity while 30% reported use because friends and family used the products (Wang et al., 2019). Adolescents often obtain these products from in-person or online retail stores. Many buy ENDS from friends, have others make the purchase for them, or receive the products as gifts (Pepper et al., 2019).

About one-third of students perceive little to no harm from intermittent e-cigarette use (i.e., using ENDS "some" days rather than every day) (Wang et al., 2019). Only 30% of adolescents believe that ENDS are less harmful than traditional cigarettes, suggesting that a large proportion of youth are not aware of the harmful chemicals and negative health impacts associated with ENDS (Ambrose et al., 2014; Amrock et al., 2015). Youth who believe that e-cigarettes are less harmful to their health or less addictive than traditional cigarettes are more

susceptible to e-cigarette use (Coleman et al., 2016; Kwon et al., 2018). Roughly 24% of youth who have never used e-cigarettes are considered susceptible to ENDS uptake due to positive product perceptions and psychological factors, such as rule-breaking tendencies and rebellious behaviors (Kwon et al., 2018). Advocates of ENDS also report perceived health benefits, smoking cessation, and enjoyable product taste and smell as reasons to use e-cigarettes (Romijnders et al., 2018; Tan et al., 2016).

Evidence shows that e-cigarettes and traditional cigarettes are complementary products, rather than substitutes (Abouk & Adams, 2017). Adolescents who use ENDS are twice as likely to hold intentions to smoke traditional cigarettes (Bunnell et al., 2015), and are twice as likely to initiate cigarette use compared to those who have never used ENDS (Loukas et al., 2018). Nearly all tobacco use begins prior to age 18 (U.S. Department of Health and Human Services, 2012). ENDS may serve as "gateway" products for adolescents as early initiation is associated with a higher risk of combustible tobacco product use later in life (Leventhal et al., 2015; Primack et al., 2015). Widespread nicotine exposure has increased due to ENDS use and has been linked to future substance abuse (Yuan et al., 2015).

Adolescents are often considered a vulnerable population due their susceptibility and perceived disadvantage in the marketplace (Grier & Kumanyika, 2010). The discretionary income of adolescents and the influence they have on their parents' purchases makes them an attractive consumer segment (Calvert, 2008). As modes of influence multiply, adolescents encounter more paths through which they may be targeted by advertising and marketing efforts (Calvert, 2008; Grier & Kumanyika, 2010). Young adults, minorities, and low-income individuals are disproportionately more likely to use ENDS and traditional cigarettes, in part due to targeting tobacco companies (Spears et al., 2019). A 2014 congressional report found that e-

cigarette companies use targeted marketing techniques to reach adolescents, relying on youth-oriented events, social media, celebrity-endorsed advertising, and free product samples (Office of Senator Richard J. Durbin, 2014). Moreover, adolescent exposure to ENDS advertisements leads to initiation of the product and the experimentation with addictive products, like cigarettes and hookahs (Hansen et al., 2020).

B. IMPACTS OF ENDS ON HEALTH

The recent emergence of ENDS, their varied and quickly changing ingredients, and the lack of regulation makes it difficult to determine the full health impacts. Nicotine, however, is a key ingredient in e-cigarette products and is widely known as being highly addictive and particularly harmful to adolescents (U.S. Department of Health and Human Services, 2016; Yuan et al., 2015). ENDS are often considered less harmful than combustible tobacco products, like cigarettes and cigars (Ambrose et al., 2014; Glasser et al., 2017; Tan et al., 2016), although there is evidence that ENDS contain unknown toxic ingredients that are harmful to the lungs (Coleman et al., 2016; National Institute on Drug Abuse, 2020; Tierney et al., 2016). Combinations of nicotine, tobacco, and unknown chemicals contribute to a long list of health issues such as inflammatory lung disease, asthma, and acute respiratory distress (Farsalinos et al., 2014; Sommerfeld et al., 2018). Although exposure to e-cigarette toxins is less harmful than traditional cigarettes (Grana et al., 2014), the products do contain high levels of nicotine and several carcinogens (Czogala et al., 2014; Goniewicz et al., 2014).

Following reports of lung injury and mysterious pulmonary diseases associated with ENDS use, one study found that 95% of participants were hospitalized and 26% were intubated or put on mechanical ventilation (Layden et al., 2020). Symptom locations linked to ENDS use ranged from respiratory to gastrointestinal to constitutional (Layden et al., 2020). Patients across

several studies commonly presented with respiratory symptoms upon hospitalization, the most common being shortness of breath, cough, nausea, vomiting, fever, chest pain, diarrhea, and abdominal pain (Kalininskiy et al., 2019; Layden et al., 2020; Sommerfeld et al., 2018). Adolescent e-cigarette users, specifically, showed increased rates of chronic bronchial issues (McConnell et al., 2016). Other studies have found that ENDS users experience acute lung injury, respiratory distress, and chronic inflammation of the lungs (Mukhopadhyay et al., 2020; Sommerfeld et al., 2018). In a study of more than 19,000 ENDS users, nearly 60% of respondents reported side effects, especially dry mouth or throat, and patients with preexisting respiratory diseases, such as asthma and obstructive lung diseases, reported worsened symptoms (Farsalinos et al., 2014).

C. EXTERNAL INFLUENCES OF ADOLESCENT ENDS USE

Advertising for e-cigarettes was virtually nonexistent prior to 2012 and, since 2014, there has been a sharp increase in both e-cigarette advertising and product use (Collins et al., 2019; Evans-Polce et al., 2020). E-cigarette advertising expenditures increased from $48 million in 2017 to $110 million in 2018 (Ali et al., 2020). Although TV advertisements for ENDS may be effective at encouraging traditional smokers to quit (Dave et al., 2019), adolescent exposure to ENDS advertisements is associated with increased odds of experimentation and frequency of product use (Hansen et al., 2018; Singh et al., 2016).

Advertising restrictions on traditional cigarettes have proven to be effective measures to reduce youth smoking (Lovato et al., 2011; U.S. Department of Health and Human Services, 2012). E-cigarettes, however, are not subject to nearly the same level of restrictions. Currently, the only existing federal requirement on e-cigarette advertisements or products is the inclusion of a warning statement, such as, "Smokeless tobacco is addictive." (U.S. Food and Drug

Administration, 2018). Public service announcements (PSAs), similar to required warning labels on packaging, tend to be effective measures for alerting consumers of harmful ingredients in products. Among young adults, exposure to anti-vaping PSAs is associated with a lower intention to vape, smoke, and purchase tobacco products (Tan et al., 2018).

Despite high rates of ENDS ownership, adolescents report frequent sharing of devices and/or flavored e-liquids, suggesting that the practice is often socially-motivated (Pepper et al., 2019). Dual users (i.e., those who use both ENDS and traditional cigarettes) admitted to alternating between vaping and smoking depending on which norms matched those of their surrounding peers (Robertson et al., 2018). Adolescents respond to peer-centered advertisements, showing more positive responses if the featured individual/group mirrors their own peer group or lifestyle (Kim et al., 2020; Padon et al., 2018). Moreover, while older adult users tend to use ENDS as smoking cessation tools, young adults were found to use e-cigarettes to be perceived as "trendy" or "cool," (Coleman et al., 2016).

Social media is a popular medium through which products are advertised and adolescents are targeted (Office of Senator Richard J. Durbin, 2014; Phua et al., 2018). Through social networking sites, like Snapchat, Instagram, Twitter, and Facebook, adolescents frequently follow companies of interest and learn of new products (Phua et al., 2017). Many companies rely on social media advertisements with celebrity endorsements to target young consumers (Office of Senator Richard J. Durbin, 2014). Consumers often hold more favorable attitudes toward products endorsed by celebrities and subsequently, purchase the promoted products (Phua et al., 2018). Among adolescents, people- and product use-themed advertisements for ENDS are associated with an increased likelihood of purchasing e-cigarettes (Barnes et al., 2020).

Television (TV) advertisements were found to increase youth e-cigarette use, resulting in a higher probability of future use among females compared to males (Pike et al., 2019). Following exposure to TV advertisements for ENDS, Farrelly et al. (2015) found that adolescents who had never used e-cigarettes held more favorable attitudes and higher intentions to try the products than they did prior to advertisement exposure. Tracking participants over time, it was found that roughly 14% of adolescents who were "never-users" initiated ENDS use within one year of recalling exposure to e-cigarette advertisements (Hansen et al., 2020). There was also a significant association between exposure to ENDS advertisements and the initiation of traditional cigarettes and hookahs one year later, indicating that ENDS advertisements are related to experimentation with other tobacco products (Hansen et al., 2020).

This research builds on the current literature, contributing evidence on the relationship between ENDS advertisement exposure and adolescent ENDS use. The goal of this study is to inform future policy measures and regulations that aim to protect vulnerable groups, like adolescents, from targeted marketing of harmful, addictive products.

3. THEORETICAL FRAMEWORK

Marketing can shape consumer behavior, often without awareness on the part of the consumer (Bandura, 1985). Advertising and other forms of marketing are utilized by firms to connect consumers to products and services that are on the market. Marketing measures have expanded over the years, increasing in specificity, influence, and reach (Moore et al., 1996; Sheth & Sisodia, 2005). Targeted marketing is an effective marketing strategy used to connect specific consumers with a product or service, rather than relying on a one-size-fits-all approach to marketing (Grier & Kumanyika, 2010). Kotler and Armstrong (2003) note that targeted marketing is understood as the identification of a group of individuals who share common characteristics, needs, or wants.

A prominent public health concern revolves around targeted marketing of harmful products, such as tobacco or alcohol, to segments of the market that are considered vulnerable (Moore et al., 1996; Pollay, 1995). Vulnerable populations are described as consumer segments that are particularly likely to be disadvantaged by the effects of product consumption (Moore et al., 1996; Smith & Cooper-Martin, 1997). Subgroups of the population that are often considered vulnerable include adolescents, women, the elderly, ethnic minorities, and low-income communities (Menzel-Baker et al., 2005; Smith & Cooper-Martin, 1997). Not all attempts to target these markets are deserving of criticism, such as targeting and advertising for healthful products. Armstrong et al. (2015) note that, with targeted marketing, the concern is not who is

being targeted, but how and for what purpose. Socially responsible marketing, therefore, calls for a company's consideration of not only their interests, but also the interests and well-being of the market segment that is targeted (Armstrong et al., 2015).

The subgroups mentioned above may be considered vulnerable due to (1) a higher perceived susceptibility to the advertising and marketing techniques employed, or (2) increased risk of harm from the products being advertised (Grier & Kumanyika, 2010). Adolescents are generally considered attractive segments of the market due to their considerable and increasing buying power, their influence over parental purchases, their easy adoption of new technologies, and their heavy use of media and the Internet (Calvert, 2008). Children and adolescents need protection within the marketplace due to their lesser ability to recognize persuasive content compared to adults, leading to increased susceptibility to advertising techniques (Grier & Kumanyika, 2010).

Due to the negative impacts of nicotine and other chemicals on the adolescent brain, adolescents are at a higher risk of harm, linked to ENDS advertisements, compared to adults (Grier & Kumanyika, 2010; Yuan et al., 2015). Specific to tobacco products, Lovato et al. (2011) identified three primary methods used to assess advertising and promotion techniques: (1) exposure, (2) receptivity, and (3) perception of advertising. Exposure was defined as subjection to advertisements found in magazines or other print mediums, on billboards, television, radio, and in retail outlets. Researchers measured exposure with recall and observational techniques, brand/product identification after viewing an advertisement, and by analyzing participant visits to stores or websites that promoted tobacco products (Lovato et al., 2011). Receptivity of tobacco advertising was identified as one's ability to name a specific advertisement or brand, or by owning a product that was advertised to them. Perceptions of

advertising were measured through questions about an individual's decision to use tobacco products or their approval of tobacco advertising. Because tobacco and ENDS advertising techniques are comparable, advertising for ENDS may be assessed using similar methods. Advertising to a target market may be regarded as harmful when a consumer is exposed to, receptive to, or holds a positive perception of harmful products, such as tobacco products or e-cigarettes, following their exposure to a targeted advertisement (Lovato et al., 2011).

This research aimed to determine the association, if any, between ENDS use and exposure to e-cigarette advertisements. Targeted marketing is applied to this research as a theory to understand how exposure to advertisements may correlate to adolescents' use of e-cigarettes. The theory motivates this research by explaining a potential relationship between Internet, print, retail, and TV advertisements and the consumption of a product known to be harmful. It was predicted that there will be a positive relationship between each channel of e-cigarette advertisement and adolescent ENDS use.

The hypotheses of this research are the following:

1. There will be a positive correlation between advertisement exposure and ENDS use.
    a. Exposure to advertisements or promotions on the Internet will be positively associated with adolescent use of ENDS.
    b. Exposure to advertisements or promotions in newspapers and magazine will be positively associated with adolescent use of ENDS.
    c. Exposure to advertisements or promotions in convenience stores, supermarkets, or gas stations will be positively associated with adolescent use of ENDS.
    d. Exposure to advertisements or promotions on through TV, streaming services, or movies will be positively associated with adolescent use of ENDS.

4. DATA, MEASURES, AND METHODS

A. DATA

The National Youth Tobacco Survey (NYTS) is a repeated cross-sectional survey conducted annually from 1999 to 2019 by the Centers for Disease Control and Prevention (CDC). The data were weighted to be nationally representative of the United States adolescent population (i.e., ages 11–18). The survey draws its sample from participating schools across the United States using a stratified, three-stage sampling procedure, including primary sampling units (e.g., counties), schools, and classrooms within schools (NYTS, 2019). Students in grades 6 to 12, in both private and public schools, participate in the school-based survey. Parental consent is assumed unless a form is signed by parents which prohibits a child from participating in the study. In 2019, the survey was administered electronically for the first time.

SAMPLE

A total of 19,018 students completed the 2019 NYTS survey. The analysis sample included 18,000 observations after removing cases with missing data. The analysis focused on participants who fell in the adolescent age range of 11 to 18 (98.9%), a decision informed by human development theory (Lerner, 2002). Students age 9, 10, and 19 were excluded from the sample because they did not fall into the identified adolescent age range. Table 1 shows the demographic characteristics for the 2019 NYTS sample and the analysis sample; the two samples are nearly identical although statistical tests were not performed to compare the samples. The

mean age of participants in the analysis sample was 14.5 years (SD = 2.03). About half were male (51%) and high school students (grades 9–12) comprised 53% of the sample. The largest ethnic group was Non-Hispanic (70%) followed by Mexican/Chicano(a) (16%), those who identified as another Hispanic ethnicity (11%), Puerto Rican (2.7%) and Cuban (1%). Roughly 66% of the sample was White, 19% was Black/African American followed by Alaskan Native/Native American (8%), Asian (7.5%), and Hawaiian Native/Pacific Islander (3.5%). Lastly, 33% of adolescents in the analysis sample have used ENDS.

Table 1

Demographics of the 2019 NYTS Sample and the Analysis Sample

Variable	2019 NYTS Sample	Analysis Sample
Male	51.5%	51.4%
Female	47.8%	48.6%
High School	53.1%	53.2%
Middle School	46.5%	46.8%
Age 11	5.8%	5.8%
Age 12	14.7%	14.9%
Age 13	16.2%	16.4%
Age 14	14.8%	14.9%
Age 15	13.6%	13.9%
Age 16	13.3%	13.4%
Age 17	13.3%	13.5%
Age 18	7.2%	7.3%
Non-Hispanic	69.0%	69.7%
Mexican/Chicano(a)	16.1%	16.0%
Puerto Rican	2.8%	2.7%
Cuban	1.1%	1.0%
Other Hispanic	11.3%	11.1%
Alaskan Native/ Native American	8.1%	8.1%
Asian	7.6%	7.5%
Black/ African American	19.3%	18.8%
Hawaiian Native/ Pacific Islander	3.5%	3.4%
White	64.6%	65.6%
ENDS users	33.7%	33.2%
Total Observations	19018	18000

Data are from the 2019 National Youth Tobacco Survey (NYTS).
The analysis sample was adjusted to remove missing cases.

B. MEASURES

Table 2 details the survey items from the 2019 NYTS that are used in this research. In addition to demographic information, the NYTS asks students about their use of numerous tobacco products, including cigarettes, cigars, e-cigarettes, hookahs, and pipes. Participants' use of ENDS, as well as the degree to which they are exposed to ENDS advertisement channels (Internet, print, retail, and TV), are available in the data.

DEPENDENT VARIABLE

The use of e-cigarettes in one's entire life was measured using a question on ever-use of the products ("Have you ever used an e-cigarette, even once or twice?") (NYTS, 2019). This measure is a dichotomous categorical variable with only two response options (yes/no). Those who responded "yes" were considered to have at least experimented with ENDS at some point in their lives and were coded as 1. Those who responded "no" were considered never-users and were coded as 0.

INDEPENDENT VARIABLE

Exposure to ENDS advertisements or promotions were self-reported measures for four different channels. The four channels of exposure were through the Internet, newspapers/magazines, convenience stores/supermarkets/gas stations, and TV/streaming services (NYTS, 2019). The independent variables were categorical, and ordinal given that the response options were arranged by intensity of exposure (see Table 2). For each channel, response options included "Do not visit/read/view," "Never," "Rarely," "Sometimes," "Most of the time," and "Always". The responses were coded to reflect the gradient of exposure: "Never" and "I do not use/visit this source" were coded as 0; "Rarely" was coded as 1; "Sometimes" was coded as 2; "Most of the time" was coded as 3; "Always" was coded as 4.

Table 2

Survey Items from the 2019 NYTS

Independent Variables	Dependent Variable
ENDS advertisement exposure	ENDS use
1. When you are using the Internet, how often do you see ads or promotions for e-cigarettes? a. Never b. Rarely c. Sometimes d. Most of the time e. Always f. I do not use/visit this source 2. When you read newspapers or magazines, how often do you see ads or promotions for e-cigarettes? 3. When you go to a convenience store, supermarket, or gas station, how often do you see ads or promotions for e-cigarettes? 4. When you watch TV or streaming services (such as Netflix, Hulu, or Amazon Prime), or go to the movies, how often do you see ads or promotions for e-cigarettes?	1. Have you ever used an e-cigarette, even once or twice? a. Yes b. No

Questions are from the 2019 National Youth Tobacco Survey. The questions and response options can be found in the Appendix. Response options (a–f) were the same for each advertisement exposure question. Exposure levels (ranging 0–4) were coded the same for each question. ENDS use was coded as a binary variable: 1 = Yes, 0 = No.

COVARIATES

Sociodemographic characteristics, such as age, gender, school level, ethnicity, and race, were included as covariates. Age is a continuous variable, ranging from 11 to 18. Gender was dichotomized into male (coded as 1) and female (0). School level was dichotomized into high school (coded as 1) and middle school (0). Indicator variables were created for each ethnicity and

race. Non-Hispanic is the only indicator variable used for ethnicity, while the remaining variables, Mexican/Chicano(a), Puerto Rican, Cuban, or another Hispanic ethnicity, acted as the reference category. For this analysis, race was broken into Black/African American, White, and a third variable comprised of Alaskan-Native/Native-American, Asian, and Hawaiian-Native/Pacific Islander respondents. Black/African American and White are used as indicator variables for race while the third category acts as the reference group.

C. METHODS

Binary logistic regression models were employed to examine the relationship between advertisement exposure and the likelihood of an adolescent using e-cigarettes. Separate logistic regression models were estimated for each channel of advertisement, in addition to a full model which included all four advertisement channels together. The estimates from the logistic regression analysis should be understood in a log odds ratio; that is, as the odds or likelihood of falling into one of two groups. Each model used an alpha level of 0.05 and controlled for demographics, including age, gender, school level, ethnicity, and race. This analysis relied on the Binary Logistic Regression Model procedure in IBM SPSS Statistics Version 26.

AGE SUBGROUPS

In addition to the main analysis, a subgroup analysis of the relationship between advertising and ENDS use was conducted by age. Literature in the human development field often distinguishes between three stages of adolescence: early, middle, and late (Lerner, 2002; Spano, 2004). Adolescents' development is influenced by their parents, peers, community, school, culture, media, and world events (Spano, 2004). Differing, stage-specific outcomes may be anticipated due to changes in physical development, cognitive skills, social expectations, and self-identification (Marcia, 1980). Erikson (1980) argued that the predominant task for an

adolescent is to create a sense of self, or an identity. While he noted that identity formation does not start nor end in adolescence, he argued that throughout development, adolescents identify with "part aspects" of other individuals and are immediately affected (Erikson, 1980). For example, adolescents may consume products known to be harmful (e.g., ENDS) depending on the norms of their peer group (Coleman et al., 2016; Robertson et al., 2018). In their development, adolescents' decisions may also be driven by heightened curiosity and a shift toward independence (Spano, 2004).

Due to the possibility of age-specific outcomes related to ENDS advertisement exposure and adolescent ENDS use, participants were divided into three age subgroups: early, middle, and late adolescence. This division was used to analyze whether age ranges play a role in the relationship between advertising exposure and ENDS use. Following literature in the human development field, adolescence is commonly considered to begin at 11 and extend to 18 or 19-years old (Lerner, 2002). Since less than 1% of the NYTS sample were nineteen years old, they were excluded from the analysis sample. This research, therefore, identifies the three age subgroups as early adolescence (age 11–13), middle adolescence (age 14–15), and late adolescence (age 16–18) (Spano, 2004).

5. RESULTS

A. LOGISTIC REGRESSION RESULTS

Table 3 presents the results from the logistic regression analysis with the odds adjusted ratios reported[1]. First, exposure to each channel of advertising was examined independently accounting for age, gender, school level, race, and ethnicity. Exposure to e-cigarette advertisements through the Internet, retail, print, and TV was positively and significantly associated with ENDS use, as shown in Columns 1–4. Next, the full specification, which includes exposure to all channels of advertising, was estimated. Column 5 shows the results of the full logistic regression model. When all channels were included, exposure to print advertisements at all levels was no longer statistically significant at the 5% level, although print advertisements were still positively correlated with adolescent ENDS use. Estimates on exposure to the remaining three channels, Internet, retail, and TV, at all levels, were positive and statistically significant at the 10% level or above. The findings from each model are discussed in more detail below.

[1] Linearity of the continuous variables with respect to the logit of the dependent variable was assessed via the Box-Tidwell (1962) procedure. A Bonferroni correction was applied to the full model, resulting in statistical significance being accepted when $p < .0045$ (Tabachnick & Fidell, 2014). A lambda calculation between the Beta coefficient of age and Beta coefficient of the interaction term of age and the natural log transformation of age indicated that no power transformation was necessary for the age variable. Based on this assessment, the continuous independent variable, age, was found to be linearly related to the logit of the dependent variable.

INTERNET ADVERTISEMENT EXPOSURE

Column 1 shows that all four levels of Internet advertisement exposure are positively related to ENDS use and statistically significant at the 1% or 0.1% level. Among the different channels, advertisement exposure through the Internet had the highest odds-ratio estimates for ENDS use. Furthermore, as the level of exposure to Internet advertisements increased, the odds of using ENDS increased. If an adolescent rarely views Internet advertisements for e-cigarettes, their odds of using ENDS are 1.4 times higher than someone who never views these advertisements. Those sometimes-exposed advertisements for ENDS on the Internet are 1.6 times more likely to use ENDS than those never exposed. Adolescents exposed to Internet advertisements for ENDS most of the time are 2.2 times more likely to use ENDS than never/do not viewers. Those who are always exposed to Internet advertisements are 2.3 times more likely to use ENDS compared to the non-exposed group. These findings support the hypothesis that there is a positive correlation between ENDS advertisement exposure and adolescent use of the products. The increased likelihood of ENDS use as one moves along the gradient of exposure further supports this hypothesis. This indicates that more frequent exposure to e-cigarette advertisements is associated with a higher likelihood of using ENDS compared to those who are not exposed to advertisements on the Internet.

PRINT ADVERTISEMENT EXPOSURE

The findings for ENDS use related to print advertisements are shown in Column 2 of Table 3. The results indicate that there was a statistically significant, positive association between print advertisement exposure and adolescent ENDS use after accounting for the covariates. Across all levels of exposure, the results were significant at the 5% level. The odds of using ENDS increased as level of exposure increased. However, the magnitude of the estimates

was smaller for print advertisements than the other three channels. For an adolescent rarely or sometimes exposed to ENDS advertisements, there is a 1.2 times higher likelihood that they use ENDS compared to those not exposed. Adolescents exposed most of the time are 1.5 times more likely to use ENDS than those not exposed to ENDS advertisements. Those who always view print advertisements for ENDS are nearly 1.8 times more likely to use the products compared to those never exposed. These results support the hypothesis that there is a positive correlation between exposure to ENDS advertisements and adolescent ENDS use. There is also evidence that a higher frequency of exposure to print advertisements is associated with a higher likelihood of product use among adolescents.

RETAIL ADVERTISEMENT EXPOSURE

Table 3 Column 3 details estimates for exposure to retail advertisements. When all covariates were accounted for, there was a statistically significant, positive association between retail advertisement exposure and adolescent ENDS use. The estimates for each level of exposure were statistically significant at the 5% level. If an adolescent is rarely exposed to retail advertisements for ENDS, their odds of using ENDS are 1.3 times higher than those not exposed to ENDS advertisements. Adolescents sometimes exposed to retail advertisements are 1.5 times more likely to use ENDS compared to those never exposed to advertisements. If exposed to retail advertisements most of the time, an adolescent is estimated to be 1.9 times more likely than those never exposed to use ENDS. Adolescents always exposed to advertisements in retail settings are twice as likely to use ENDS compared to the never-exposed group. Similar to the Internet and print channels, these findings support the hypothesis of a positive correlation between ENDS advertisements and product use. The results also suggest that the more an adolescent is exposed to ENDS advertisements in retail settings, the more likely they are to use ENDS compared to

those not exposed. It is worth noting that the significance levels get smaller as the level of exposure increases. In other words, the odds-ratio estimates for ENDS use have a higher statistical significance level for those who are more frequently exposed to retail advertisements.

TV/STREAMING SERVICES ADVERTISEMENT EXPOSURE

Column 4 shows estimates for the association between ENDS TV and streaming services advertisements on ENDS use. There was a statistically significant, positive association between TV/streaming advertisement exposure and adolescent ENDS use, regardless of how frequently one is exposed. Across all levels, the estimates were significant at the 5% level. If an adolescent rarely views TV/streaming advertisements for ENDS, their odds of using ENDS are 1.3 times higher than someone who never views ENDS advertisements. Those who sometimes view advertisements for ENDS on TV/streaming services are 1.4 times more likely to use ENDS compared to never-viewers. Adolescents exposed most of the time are nearly twice as likely to use ENDS than those never exposed. Those who are always exposed to ENDS advertisements through TV/streaming services are 1.8 times more likely to use ENDS compared to the non-exposed group. These findings support the hypothesis that there is a positive correlation between ENDS advertisements and adolescent ENDS use. Overall, as the level of exposure increases, adolescents' odds of using ENDS also increases. Among the individual models, TV/streaming advertisements was the only channel that saw a drop in odds from the "most of the time" to "always" exposure level. The findings largely fit with the expectation that as one moves along the gradient of exposure, they are more likely to use ENDS than those exposed to advertisements less frequently.

EXPOSURE TO ALL ADVERTISEMENT CHANNELS

Column 5 shows the results for the full logistic regression model in which all four channels of ENDS advertisements were included. The findings from this model are particularly useful in understanding how the likelihood of using ENDS differs when all four channels of advertising are included. The estimates for each advertisement channel across all exposure levels were lower in the full specification than in previous models. However, like the previous models, the full specification shows an increased likelihood of using ENDS the more frequently an adolescent is exposed to advertisements. These results align with the prediction that as an adolescent is exposed to e-cigarette advertisements more frequently, their odds of using ENDS increase compared to those never exposed to ENDS advertisements.

Across all levels of Internet advertisement exposure, the odds of adolescents using ENDS increased by factors ranging from 1.23 to 1.70 times compared to those never exposed to Internet advertisements. Compared to the full specification, the odds-ratio estimates are lower across all exposure levels. Each estimate of exposure to Internet advertisements on ENDS use was significant at the 5% level. The findings suggest that, holding all else constant, adolescents who are always exposed to Internet advertisements have the highest odds of using ENDS. Among the different channels of advertisement exposure, Internet advertisements were most positively correlated to adolescent ENDS use.

The estimates for print advertisement exposure on ENDS use were lower in the full model than in the individual model, ranging in odds from 0.92 to 1.05. Except for the “always” level of exposure to print advertisements, the estimates were not statistically significant in the full model. These results indicate that the likelihood of using ENDS is lower for exposure to

newspaper or magazines compared to adolescent exposure to Internet, retail, and TV advertisements.

For retail advertisements, there is an increase in likelihood to use ENDS as one moves up the levels of advertisement exposure. Again, the magnitude of the estimates is smaller in the full model than in the individual model, ranging from 1.10 to 1.52. Across all levels of exposure, the odds estimates were statistically significant at the 5% level. The findings suggest that exposure to advertisements in retail settings is more highly correlated to ENDS use than print or TV advertisements, but not as highly correlated as Internet advertisement exposure.

In the full model, there is an overall lower likelihood of using ENDS if exposed to TV/streaming advertisements than in the individual model. The odds-ratio estimates on ENDS use range from 1.13 to 1.32. The “rarely” and “sometimes” exposure levels were statistically significant at the 10% level while the “most of the time” and “always” levels were significant at the 1% and 0.1% levels. Mirroring the individual model, adolescents who are always exposed to TV/streaming advertisements are slightly less likely to use ENDS than adolescents exposed most of the time.

Overall, adolescents’ odds of using ENDS are 1.32 times higher each year their age increases. The odds of using ENDS increases by a factor of 1.12 for males as compared to females and by a factor of 1.35 for those in high school compared to those in middle school. If adolescents are Hispanic, the odds of using ENDS are 1.16 times higher than for those Non-Hispanic. Individuals who are Black/African American are 1.09 times more likely to use ENDS compared to those not Black/African American. Adolescents who are White are 1.34 times more likely to use ENDS than those who are non-White.

Table 3

Logistic Regression Estimates of Exposure to E-cigarette Advertisements on ENDS Use

		Ever Use ENDS				
Exposure to Internet ads	Rarely	1.399**				1.234*
		(0.046)				(0.052)
	Sometimes	1.637***				1.385*
		(0.047)				(0.055)
	Most of the time	2.188***				1.681***
		(0.062)				(0.073)
	Always	2.304***				1.698***
		(0.078)				(0.101)
Exposure to print ads	Rarely		1.174*			1.036
			(0.044)			(0.047)
	Sometimes		1.198*			0.916
			(0.051)			(0.056)
	Most of the time		1.507**			0.939
			(0.086)			(0.094)
	Always		1.762**			1.051
			(0.105)			(0.132)
Exposure to retail ads	Rarely			1.289*		1.102*
				(0.054)		(0.058)
	Sometimes			1.525**		1.256***
				(0.052)		(0.058)
	Most of the time			1.881***		1.453***
				(0.055)		(0.062)
	Always			2.065***		1.519***
				(0.060)		(0.069)
Exposure to TV/streaming ads	Rarely				1.325**	1.132
					(0.040)	(0.044)
	Sometimes				1.371*	1.173
					(0.048)	(0.054)
	Most of the time				1.941***	1.323***
					(0.076)	(0.084)
	Always				1.845**	1.290**
					(0.095)	(0.109)
Covariates	Age	1.324***	1.318***	1.323***	1.319***	1.322***
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
	Male	1.11**	1.069*	1.087**	1.094**	1.121**
		(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
	High school	1.351***	1.359***	1.341***	1.374***	1.353***
		(0.060)	(0.060)	(0.060)	(0.060)	(0.061)
	Non-Hispanic	.875***	0.883***	0.854***	0.882***	0.861***
		(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
	Black/African American	1.096	1.100	1.105	1.076	1.088
		(0.053)	(0.053)	(0.053)	(0.053)	(0.053)
	White	1.498***	1.527***	1.456***	1.525***	1.341***
		(0.045)	(0.044)	(0.045)	(0.045)	(0.045)
Observations		18000				
Constant		0.004***	0.005***	0.004***	0.005***	0.003***
		(0.200)	(0.197)	(0.201)	(0.198)	(0.203)
Pseudo R-squared		.157	.144	.154	.150	.162

Odds Ratios are reported for each level of advertisement exposure.
*, **, *** indicates significance at the 95%, 99%, and 99.9% level, respectively.
Standard errors are reported in parentheses.
The Pseudo R-squared was calculated using the Nagelkerke approach in IBM SPSS.
For each advertisement channel, the reference group is adolescents who reported never being exposed to advertisements via that source or who reported that they do not use/view/visit that source. Full NYTS questions and responses can be found in the Appendix.

B. SUBGROUP ANALYSIS RESULTS

Table 4 shows the results for the full logistic regression model estimated for three age subgroups, early adolescence (age 11–13), middle adolescence (age 14–15), and late adolescence (age 16–18). The subgroups were analyzed to examine differences in likelihood of using ENDS by age. The full model was employed to estimate the relationship between the channels of advertisement exposure (Internet, print, retail, and TV) and ENDS use. After controlling for gender, race, and ethnicity, the findings suggest that there are differences in the relationship of interest between the three age subgroups. The differences in estimates between age groups are present both within and between advertisement channels. However, these differences were not calculated with formal statistical tests measuring differences within-models, or between-estimates across models.

Column 1 shows the estimates for advertisement exposure on ENDS use among early-adolescents (N = 6674). Compared to the other channels, exposure to Internet advertisements was most positively correlated with ENDS use and each of the estimates were significant at the 0.1% level. For the Internet channel, odds-ratio estimates ranged from 1.51 to 2.62. The print advertisement estimates ranged from 1.10 to 1.36. Advertisements in retail stores were moderately correlated with ENDS use among 11–13-year olds, and estimates ranged in odds from 1.22 to 1.52. TV/streaming advertisements were least correlated with ENDS use, ranging in odds-ratios from 1.07 to 1.28. The findings indicate that there is a positive association between e-cigarette advertisement exposure and ENDS use among adolescents age 11–13. Across nearly all advertisement channels, the odds of ENDS use increased as exposure intensity increased. These results suggest that more frequent advertisement exposure is linked with higher odds of ENDS use among early adolescents.

Column 2 details estimates for middle-adolescents (N = 5173). For this age group, the magnitude of estimates for exposure to Internet advertisements was much smaller compared to the early adolescent group. All estimates on exposure levels for Internet advertisements were significant at the 5% level except "rare" exposure. The odds-ratio estimates for Internet advertisements ranged from 1.10 to 1.71. For print advertisements, all levels of exposure were negatively correlated with ENDS use except "always" exposure; estimates ranged in odds from 0.78 to 1.04. For retail advertisement exposure, the odds of middle-adolescents using ENDS ranged from 0.98 to 1.41, indicating that ENDS use differed depending on exposure level for this age group. Compared to the other channels, exposure to TV/streaming advertisements was most positively correlated with middle-adolescent ENDS use. Across all TV/streaming exposure levels, estimates were significant at the 5% level and ranged in odds from 1.26 to 1.65. These results show that there is a positive association between Internet, retail, and TV advertisement exposure and ENDS use among middle-adolescents. An increase in exposure mostly corresponded to higher odds of ENDS use for this age group as well.

Column 3 details estimates for the late-adolescent age group (N = 6153). The findings show a positive and statistically significant relationship between exposure to Internet and retail advertisements and ENDS use. Across all four levels of Internet advertisement exposure, the odds of ENDS use were statistically significant at the 1% and 0.1% levels. The odds-ratio estimates ranged from 1.25 to 1.39 for the Internet advertisement channel. For print advertisements, the relationship between advertisement exposure and ENDS use was negative across all levels except "sometimes" exposure; estimates ranged in odds from 0.84 to 1.02. Compared to the other channels, exposure to retail advertisements was most positively correlated with late-adolescent ENDS use, ranging in odds from 1.16 to 1.66. The estimates for retail

advertisement exposure were significant at the 5% level across all levels except for “rare” exposure. Exposure to TV/streaming advertisements among late-adolescents was somewhat correlated to ENDS use, ranging in odds from 0.79 to 1.27. “Rarely” and “most of the time” exposure levels were positively associated with ENDS use while “sometimes” and “always” exposure levels were negatively correlated with ENDS use. However, these estimates were not statistically different from zero. These findings indicate that there is a positive association between Internet and retail advertisement exposure and ENDS use among late-adolescents.

In summary, the Internet advertisement channel is the most positively correlated to ENDS use among early-adolescents. The TV/streaming service advertisement channel is the most positively associated with ENDS use for middle-adolescents. Among late-adolescents, retail advertisements are the most positively correlated channel. For early-adolescents, TV/streaming service advertisements are the least positively correlated to ENDS use. Print advertisements are the least positively correlated to ENDS use for middle- and late-adolescents, and are even negatively correlated at some exposure levels. Among all age groups and all advertising channels, early-adolescent exposure to Internet advertisements is the most associated with ENDS use. Further, across all advertising channels, early-adolescents are the only age group with all positive estimates on ENDS use. These results indicate that adolescents age 11–13 are the most susceptible to ENDS use relating to advertisements. These findings provide more information on the estimates of ENDS use among distinct adolescent age groups.

Table 4

Logistic Regression Estimates for ENDS Use with Subgroup Analysis for Age

		Ages 11–13	Ages 14–15	Ages 16-18
Exposure to Internet ads	Rarely	1.505***	1.104	1.250**
		(0.108)	(0.091)	(0.079)
	Sometimes	1.841***	1.237*	1.323***
		(0.113)	(0.096)	(0.086)
	Most of the time	2.622***	1.494***	1.390***
		(0.139)	(0.125)	(0.116)
	Always	2.538***	1.710***	1.267**
		(0.191)	(0.159)	(0.161)
Exposure to print ads	Rarely	1.133	0.994	1.016
		(0.095)	(0.082)	(0.071)
	Sometimes	1.102	0.952	0.838*
		(0.113)	(0.096)	(0.084)
	Most of the time	1.121	0.784	0.975
		(0.175)	(0.154)	(0.159)
	Always	1.362	1.035	0.928
		(0.235)	(0.228)	(0.208)
Exposure to retail ads	Rarely	1.217	0.982	1.156
		(0.118)	(0.102)	(0.090)
	Sometimes	1.343*	1.071	1.365**
		(0.119)	(0.101)	(0.089)
	Most of the time	1.423**	1.407***	1.522***
		(0.127)	(0.107)	(0.095)
	Always	1.519***	1.331*	1.659***
		(0.138)	(0.121)	(0.108)
Exposure to TV/streaming ads	Rarely	1.068	1.310*	1.028
		(0.088)	(0.077)	(0.069)
	Sometimes	1.105	1.259*	0.927
		(0.105)	(0.092)	(0.085)
	Most of the time	1.277	1.387*	1.274
		(0.158)	(0.144)	(0.135)
	Always	1.280	1.653*	0.792
		(0.215)	(0.209)	(0.0185)
Covariates	Male	1.160*	1.084	1.132*
		(0.068)	(0.059)	(0.053)
	Non-Hispanic	0.730***	0.847*	0.999
		(0.074)	(0.068)	(0.059)
	Black/African American	1.500***	1.111	0.846*
		(0.099)	(0.092)	(0.084)
	White	1.161	1.454***	1.708***
		(0.087)	(0.079)	(0.069)
Observations		6674	5173	6153
Constant		0.082***	0.310***	0.419***
		(0.122)	(0.104)	(0.094)
Pseudo R-squared		.057	.041	.050

Odds Ratios are reported for each level of advertisement exposure.
*, **, *** indicates significance at the 95%, 99%, and 99.9% level, respectively.
Standard errors are reported in parentheses.
The Pseudo R-squared was calculated using the Nagelkerke approach in IBM SPSS.
For each advertisement channel, the reference group is adolescents who reported never being exposed to advertisements via that source or who reported that they do not use/view/visit that source. Full NYTS questions and responses can be found in the Appendix.

6. DISCUSSION AND LIMITATIONS

A. DISCUSSION

Findings from this study are consistent with the existing literature, supporting a positive relationship between ENDS advertisement exposure and ENDS use (Collins et al., 2019; Hansen et al., 2020; Mantey et al., 2016; Singh et al., 2016). The findings from this research indicate that exposure to Internet, retail, and TV/streaming service advertisements is associated with an increased probability of ENDS use among all adolescents. For early-adolescents (ages 11–13), Internet and retail advertisement channels are the most positively correlated to ENDS use while print advertisements are least correlated. These results are in line with the findings of Singh et al. (2016). In comparison to the middle- and late-adolescent groups, early-adolescents were found to be more likely to use ENDS across all advertising channels. This finding suggests that younger adolescents are more susceptible to ENDS use, which may be attributed to heightened curiosity (Wang et al., 2019), peer influence (Kim et al., 2020), or advertisement exposure (Padon et al., 2018; Pike et al., 2019). Future research should explore why younger adolescents are more likely than older adolescents to use e-cigarettes, specifically, in relation to advertisement exposure.

TV/streaming advertisement exposure is the most positively correlated to ENDS use among middle-adolescents (age 14–15). The retail advertisement channel is the most positively associated with ENDS use among late-adolescents (age 16–18). Print advertisements were the least, even negatively, correlated to ENDS use for both age groups. These findings may be explained by the possibility that late-adolescents have presumably obtained driver's licenses and

may visit retail stores more frequently than middle-adolescents, resulting in increased advertisement exposure through that channel. Middle-adolescents, without their own transportation, may be less mobile and more exposed to TV/streaming advertisements compared to the other channels.

These results contribute to previous studies that demonstrate a connection between ENDS advertisement exposure and adolescents' perceptions, attitudes, intentions, and actions following exposure. Previous studies have found elevated perceptions (Farrelly et al., 2015; Padon et al., 2018) and increased consumption of ENDS among adolescents following advertisement exposure (Barnes et al., 2020). Moreover, there is evidence of an increased likelihood to use ENDS, cigarettes, and hookahs within one year of ENDS advertisement exposure (Hansen et al., 2020). This recent finding suggests that adolescents who reported advertisement exposure in the 2019 NYTS have already surpassed the timespan in which they would likely initiate other tobacco use. The increased likelihood to initiate both ENDS use and other tobacco use is particularly salient given what is known about the harmfulness of nicotine on the adolescent brain (England et al., 2015; Yuan et al., 2015).

These findings suggest that policies and programs aimed at reducing adolescent exposure to ENDS advertisements are needed to prevent e-cigarette uptake and tobacco use. Adolescents are a vulnerable population particularly susceptible to targeted marketing. The promotion of harmful products can be restricted to protect the adolescent population, for example, by limiting which age groups appear in ENDS advertisements and what content is used. Identifying risk factors for adolescents is critical given their susceptibility to ENDS use and the role of ENDS as gateway products to traditional cigarette use.

B. LIMITATIONS

The evidence from this research has several limitations. First, other reported tobacco use was intended to be a covariate in the analysis to account for the proportion of ENDS users who were current tobacco users at the time of the survey. However, because the survey question was conditional, the analysis sample would have been restricted to a much smaller sample size (N = 4169) if the variable had been included. As a result, it is not possible to generalize these results to strictly ENDS users.

Second, the 2019 NYTS did not ask participants about when they were exposed to ENDS advertisements or when they used the products. As a result, causal inferences linking advertisements and ENDS use cannot be made. Future studies are recommended to incorporate longitudinal follow-up to assess whether there is a causal link between advertisement exposure and ENDS use. Next, responses to the survey are self-reported and, therefore, may be misreported. Finally, the NYTS is nationally-representative, but does not collect information on adolescents who are homeschooled, have dropped out of school, or those in detention centers. Therefore, the findings of this research cannot be generalized individuals in those scenarios.

C. FUTURE RESEARCH

Future research may include following individuals over time, which would allow more in-depth information to be gathered about when adolescents were exposed to e-cigarette advertisements in relation to when they used ENDS. This would allow researchers to understand more about the causation of ENDS use. Research may also investigate potential explanations as to why younger adolescents may be more susceptible to ENDS use compared to the other age groups. For example, research may analyze whether younger adolescents spend more time on the Internet and social media or whether they are particularly influenced by their peers. Finally,

future research should investigate the potential influence on adolescent ENDS use of parents and other household members who use e-cigarettes.

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APPENDIX

2019 National Youth Tobacco Survey (NYTS) Questions:

34. Have you ever used an e-cigarette, even once or twice?

a. Yes
b. No

93. When you are using the Internet, how often do you see ads or promotions for e-cigarettes?

a. I do not use the Internet
b. Never
c. Rarely
d. Sometimes
e. Most of the time
f. Always

94. When you read newspapers or magazines, how often do you see ads or promotions for e-cigarettes?

a. I do not read newspapers or magazines
b. Never
c. Rarely
d. Sometimes
e. Most of the time
f. Always

95. When you go to a convenience store, supermarket, or gas station, how often do you see ads or promotions for e-cigarettes?

a. I never go to a convenience store, supermarket, or gas station
b. Never
c. Rarely
d. Sometimes
e. Most of the time
f. Always

96. When you watch TV or streaming services (such as Netflix, Hulu, or Amazon Prime), or go to the movies, how often do you see ads or promotions for e-cigarettes?

a. I do not watch TV or streaming services, or go to the movies
b. Never
c. Rarely
d. Sometimes
e. Most of the time
f. Always