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Perceptions of E-cigarettes and Tobacco-Related Harm Among U.S. Adolescents: Findings From the 2020 National Youth Tobacco Survey

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PERCEPTIONS OF E-CIGARETTES AND TOBACCO-RELATED HARM AMONG U.S ADOLESCENTS; FINDINGS FROM THE 2020 NATIONAL YOUTH TOBACCO SURVEY

by

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Under the Direction

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ABSTRACT

Background: There has been a substantial increase in the worldwide use and popularity of electronic cigarettes (e-cigarettes) in recent years, especially among youth. However, little is known about the differences in e-cigarette and tobacco-related harm perceptions among U.S. adolescents by smoking status, gender, and age. Therefore, this study sought to assess the prevalence of perceptions of tobacco-related harm among youth by smoking status (e-cigarette users, cigarette users, and non-users), gender, and age. This study also examined the association between the perceptions of peer-related e-cigarette and cigarette use with actual e-cigarette and cigarette use among youth. **Method:** Analyses were conducted using the 2020 National Youth Tobacco Survey. The National Youth Tobacco Survey is a nationally representative sample of middle school and high school students in the United States (n=14,531). This survey is also listed as one of the exempt studies for designation of non-human subject research for Georgia State University Research Administration. Data were analyzed using SPSS program version 28. Cross-tabulations and Chi-square tests were used to assess perceptions of harm of e-cigarettes and cigarettes by smoking status, gender, and age. **Results:** Approximately 45% of non-tobacco users believed that e-cigarettes are harmful, yet only 22% of cigarette and e-cigarette users believed that e-cigarettes are harmful. Additionally, 19% of non-e-cigarette users and 16% of non-cigarette users believed that the vapor from cigarettes is harmful, yet only 9% of the same group believed that the vapor from e-cigarettes is harmful. Moreover, Prevalence of high school students for harm perceptions of both cigarettes and e-cigarettes was consistently lower compared to middle school students. E-cigarette users were more likely to believe that ten out of every ten students in their grade use e-cigarettes ($p<0.001$). **Conclusion:** A lower prevalence of e-cigarette and cigarette users endorsed harmful perceptions of e-cigarette and cigarette use compared to non-users. Overall, e-cigarettes were perceived as less harmful compared to cigarettes among youth.

ACCEPTANCE

This thesis, PERCEPTIONS OF E-CIGARETTES AND TOBACCO-RELATED HARM AMONG U.S ADOLESCENTS; FINDINGS FROM THE 2020 NATIONAL YOUTH TOBACCO SURVEY, by Reem Alluhibi was prepared under the direction of the Master's Thesis Advisory Committee of the Respiratory Therapy department at Georgia State University. It is accepted by the committee in partial fulfillment of requirements for the Master of Science degree in Respiratory Therapy at Byrdine F. Lewis College of Nursing and Health Professions, Georgia State University. The Master's Thesis Advisory Committee, as representatives of the faculty, certifies that this thesis has met all standards of excellence and scholarship as determined by the faculty.

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Reem Alluhibi

DEDICATION

It is with genuine gratitude and warm regard that I dedicate this work to my God (Allah), my strong pillar, my source of inspiration, wisdom, knowledge and understanding. I also dedicate this work to my parents who have encouraged me all the way and whose encouragement has made sure that I give it all it takes to finish what I have started. To my friends who never failed to always believe in me. I am so blessed to have all of this support and forever grateful.

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CHAPTER I

Introduction

There has been a markedly increase in the worldwide use and popularity of electronic cigarettes (e-cigarettes) in recent years. E-cigarettes or otherwise known as nicotine vaping products (vapes), are devices that heat liquids that usually contain nicotine and flavor into an aerosol (Cullen et al., 2019). A recent study in 2019 that included 19,018 United States students found that around 4.1 million high school students and 1.2 million middle school students currently use e-cigarettes. (Cullen et al., 2019). Moreover, for the past five years, the most commonly used tobacco product by middle and high school students has been e-cigarettes (Jamal, 2017). E-cigarettes are now becoming more popular among adolescents who have never smoked, and studies have shown an increased risk of using other forms of tobacco and harmful substances in the future among e-cigarette users (Chadi et al., 2019). One of the reasons contributing to e-cigarettes' popularity is that they are being marketed as a safer and healthier option for smoking. However, there is still a lack of evidence for the safety and long-term adverse effects of e-cigarette use (Chadi et al., 2019). Although some studies have shown that e-cigarettes can be helpful in smoking cessation, there is no clear evidence that e-cigarettes may be beneficial as a smoking reduction or cessation tool, especially for youth, and many pose that their harm outweighs the benefits (Chadi et al., 2019). Several recent studies have addressed the dangerous and long-term effects of e-cigarettes on the youth population. Moreover, there is building evidence that using products that contain nicotine during adolescents does not only have severe consequences on addiction and mental health, but nicotine exposure may also affect the development of the adolescent brain (Grant et al., 2019; Yuan et al., 2015).

The perception of harm for e-cigarettes plays a significant role in the increased use of e-cigarettes among the youth population, as studies have found an association between lower perceived harm of e-cigarettes with increased use among youth (Mattingly et al., 2020, 2021). For instance, a recent study described the perception of e-cigarettes and non-cigarette tobacco products among U.S youth and found that nearly 3 out of 4 youths believed that e-cigarettes were less harmful than cigarettes, and nearly half believed that e-cigarettes were less addictive than cigarettes (Amrock et al., 2016). On the other hand, there are few studies that compare the perceptions of tobacco-related harm based on smoking status among the youth population. This study will utilize a national survey to investigate the prevalence of tobacco-related perceptions of harm among youth, comparing e-cigarette users, cigarette users, and non-users, and the perceptions of tobacco-related harm between male and female, as well as between older and younger youth. The study hypothesizes that the prevalence of tobacco-related harm perceptions differs among youth based on their smoking status, gender, and age. The study hypothesizes that e-cigarette users and cigarette users have lower harm perceptions compared to non-users. Moreover, Male harm perceptions toward tobacco products will be lower compared to females. Lastly, older aged youth will have lower harm perceptions toward cigarettes and e-cigarettes compared to younger aged youth.

Statement of Problem

E-cigarettes are the most commonly used tobacco product among high school and middle school students (Gentzke et al., 2019). The number of students using e-cigarettes is increasing, and in 2018, around 3.6 million students reported using e-cigarettes compared to 2 million students in 2017 (Gentzke et al., 2019). E-cigarettes were first invented as a smoking cessation

tool; however, they are becoming more popular among adultescents who have never smoked, and studies have shown that there is an increased risk of using other forms of tabaco and harmful substances in the future among e-cigarettes users (Chadi et al., 2019). Moreover, e-cigarettes are widely thought to be safer than combustible cigarettes, however, there are numerous studies indicating the toxicity of e-cigarettes and multiple health risks associated with the use of e-cigarettes especially on adultescents. Emerging evidence suggest that e-cigarette vapor may have negative cardiovascular and pulmonary effects (Bernat et al., 2018). Furthermore, e-cigarettes liquid usually contain nicotine and it has also been shown that nicotine is responsible for causing epigenetic changes to the adolescent brain making them prone to future substance use (Yuan et al., 2015). With all these e-cigarettes' harm effects imposed on adolescents; little is known of adolescents' perceptions of these health risks. There are few studies done to evaluate the differences in e-cigarette and tobacco-related harm perceptions among U.S. adolescents by smoking status, gender, and age. As well as the association between the perceptions of peer-related e-cigarette and cigarette use with actual e-cigarette and cigarette use.

Purpose of the Study

This study will conduct a secondary data analysis of a national survey to investigate the prevalence of tobacco-related harm perceptions among youth comparing e-cigarette users, cigarette users, and non-users, and the perceptions of tobacco-related harm between older aged youth and younger aged youth. The purpose is to determine the prevalence of tobacco-related harm perceptions among youth who report e-cigarette use, cigarette use, and non-cigarette/e-cigarette use. This study also seeks to determine differences in tobacco-related harm perceptions among various age groups of youth.

Significance of the Study

Understanding the perceptions of tobacco related harm among youth comparing four different aspects such as smoking statues, gender, and age as well as perceptions of peer-related cigarette and e-cigarette use will help in planning health education content in schools and social media. Moreover, identifying the most affected population of perceiving e-cigarettes as not harmful will help targeting this population by spreading awareness and enhancing the knowledge on health consequences to that specific population.

Research Questions

1. What is the prevalence of perceptions of tobacco-related harm among youth comparing e-cigarette users, cigarette users, and non-users?
2. What is the prevalence of perceptions of tobacco-related harm between male and female youth?
3. What is the difference in prevalence of the perceptions of tobacco-related harm between older aged youth and younger aged youth?
4. What is the association between the perceptions of peer-related cigarette and e-cigarette use with actual cigarette and e-cigarette use among youth?

Limitations

The present study has several limitations. First, due to the cross-sectional nature of the present study, causality cannot be established. Future research should examine how harm perceptions is associated to initiation and use of e-cigarettes in longitudinal studies. Second, data used in this study is self-reported which might lead to social desirability bias and recall bias.

CHAPTER II

Literature Review

E-cigarettes History

Vaping products were invented in 2003 and introduced to the U.S. market in 2006 as aids for smoking cessation and as safer alternative to smoking. E-cigarettes have evolved from early generation cigarette lookalikes that were disposable, resembled conventional cigarettes in shape, to modifiable tank-style e-cigarettes, to the recent emergence of a rechargeable, sophisticated, discreet high-tech device pod mods or "pods." Among pod mods, the most commonly known JUUL, which was first introduced in 2015 (Fadus et al., 2019). JUUL devices are currently the most popular e- cigarette brand in the U.S. accounting for 76% of e-cigarettes market. In 2017, a national U.S. survey was conducted among people aged 15–24 years reported that 8% of youth and young adults used JUUL in the past 30 days (Huang et al., 2019). In 2019 National Youth Tobacco Survey (NYTS), around 60% of participating middle and high school students reported that JULL is their main choice of e-cigarette brand (Hamberger & Halpern-Felsher, 2020). JUUL devices are small, rechargeable, battery-powered e-cigarettes often shaped like USB flash drives which aerosolize liquid solutions that contain nicotine, a liquid solvent such as propylene glycol (PG) or vegetable glycerin (VG), other additives like flavorings and colorants (Bhatt et al., 2020).

Prevalence of E-cigarette Use among Adolescents in the U.S.

Although e-cigarettes were first designed as smoking cessation tool, vaping has become prevalent among middle and high school students. Combustible cigarettes use among youth has declined significantly since the late 1990s, yet the overall nicotine products use has increased due to the presence of e-cigarettes (Fadus et al., 2019; Hamberger & Halpern-Felsher, 2020).

National surveys conducted over 43 thousand students throughout the U.S. report yearly rises in nicotine vaping among middle and high school students since 2016. In 2019, around 35% of 17-18 years old students reported use of e-cigarettes in the past 12 months and around 12% reported daily use of e-cigarettes (Hamberger & Halpern-Felsher, 2020). A recent study in 2019 included 19 018 United States students found that around 63.6% of high school students and 65.4% of middle school students reported exclusive use of e-cigarettes, and an estimated of 4.1 million high school students reported current use (Cullen et al., 2019). Moreover, More than 5.2 million young people in the U.S. reported current use of e-cigarettes in 2019, around 28% were high school students and 10% were middle school students (King et al., 2020).

Toxicology of E-Cigarettes

E- Cigarettes' liquids usually contain four main ingredients nicotine, flavorings, water, and a humectant such as propylene glycol (PG) and glycerol. Several studies have identified a wide variety of chemical components in the cartridges, refill solutions, and aerosols of e-cigarettes. In a study done in 2015, researchers have detected approximately 60 to 70 compounds in different e-cigarettes' liquids. Another study done in 2016 have identified 113 chemicals in 50 brands of liquids. Substances identified in e-cigarette liquids and aerosols include nicotine, humectants (PG and glycerol), tobacco-specific nitrosamines (TSNAs), aldehydes, metals, volatile organic compounds (VOCs), phenolic compounds, polycyclic aromatic hydrocarbons (PAHs), flavorings, and tobacco alkaloids. The most frequently reported short term adverse events reported by e- cigarettes users include throat and mouth irritation which is due to water absorbing property of PG and glycerol from mouth and throat mucosa (Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems et al., 2018; Fadus et al., 2019). Other than the known chemicals in e-cigarettes liquid, there are a number of new

hazardous chemicals that is produced as a result of heating the liquid. For example, several studies have shown that e-cigarettes emit toxic carbonyl compounds as a result of thermal chemical reaction of the liquid ingredients. A study done in 2016 detected up to 31 carbonyl compounds such as formaldehyde, acetaldehyde, glycidol, acrolein, acetol, and diacetyl, in e-cigarette aerosols from different devices (Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems et al., 2018).

Health Concerns Regarding E-cigarettes

E- cigarettes are free from the process of combustion reducing the release of harmful chemicals and carcinogens. For that reason, e-cigarettes are widely perceived to be safer than combustible cigarette. However, there is a growing body of evidence indicating related health risks associated with the use of e-cigarettes. The liquid used in e- cigarettes is composed of vegetable glycerin, propylene glycol, nicotine, and flavoring agents (Chun et al., 2017). Although vegetable glycerin and propylene glycol are designated by the FDA to be generally safe, this designation is for oral intake and does not apply to heating and aerosolization and there are no studies conducted for long term effects of consuming the aerosol of heated vegetable glycerin and propylene glycol in humans (Chun et al., 2017). Moreover, the liquid used in e-cigarettes contains high amount of nicotine in concentrations ranging from 12 to 100 mg of nicotine per ml (Chun et al., 2017). Thus, with no surprise nicotine exposure among youth who uses e- cigarettes is higher than those who only smoke combustible cigarettes (Goniewicz et al., 2018). One of the main issues with high nicotine consumption especially for the young population is the adverse effect of nicotine on brain development (Yuan et al., 2015). It has been shown that using drugs that contain nicotine during adolescence triggers lasting changes in neuronal signaling and may have potentially severe effects for teen addiction, cognition, and

emotional regulation (Yuan et al., 2015). Another major health concern of e-cigarettes is its adverse effects on the respiratory and cardiovascular systems. A recent study found a significant association of e-cigarette use with bronchitis symptoms including daily cough, congestion or phlegm for 3 months in a row in adolescents (McConnell et al., 2017). Another study was conducted among adolescents found an independent significant association between e-cigarette use and asthma (Schweitzer et al., 2017). This study's results were consistent with another study findings showing an association of asthma with e-cigarette smoking (Choi & Bernat, 2016). E-cigarettes are not only linked to asthma and bronchitis, a recent increased number of cases admitted to hospitals with severe lung disease were linked to the use e- cigarettes which is now referred to as E-cigarette or Vaping Associated Lung Injury (EVALI). In 2020, a total of 2602 cases of EVALI had been reported to the CDC from all around the U.S. (King et al., 2020). Up to 30% of individuals diagnosed with EVALI required mechanical ventilation and up to 70% required admission to intensive care units (Virgili et al., 2022). Among all patients diagnosed with EVALI 67% of them were male, and the median age is 24, and up to 86% are associated with vaping of THC-containing products (THC, the psychoactive ingredient in marijuana)(Winnicka & Shenoy, 2020).

E-cigarettes and Future Combustible Cigarettes Use

Understanding the impact of e-cigarettes on public health requires consideration of not only the health risks of e-cigarettes on individuals but also the effect of e-cigarettes use on future use of other harmful products such as combustible tobacco cigarettes and cannabis. According to the National Academies of Sciences, Engineering, and Medicine in 2018, The overall prevalence of cigarette smoking will determine the ultimate impact of e-cigarettes on public health. The prevalence of adult who use e-cigarettes in the past 30 days is 5%, much lower than e-cigarettes

use among youth, and almost all adults in this study reported e-cigarettes use after being regular smokers. On the other hand, many youth users had never used a tobacco product before initiating e-cigarette use. In a study done in 2017, 12.5% of young adults aged 18–24 reported e-cigarette use (any use, even one or two times) compared to only 5.8% of those age 25 and older. Several studies including meta-analysis predict that adolescents' e-cigarettes use can lead to future combustible cigarettes use. Wills and colleagues conducted a study among 9th and 10th grade students in Hawaii and found an association between e-cigarette and smoking among the studied population when they were followed up a year later. This study also found an association between the does/frequency of e-cigarettes use and smoking initiation, the probability of ever smoking at 1-year follow-up was 5% among baseline never vapers, compared to 11% for those who vaped three to four times in their life, and 19% for those who vaped weekly/daily (Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems et al., 2018). Another study done in 2017 predicted threefold increase in the risk of subsequent cigarette initiation with e-cigarette use (Fadus et al., 2019).

Perception of Tobacco and E-cigarettes-Related Harm

The perception of e-cigarettes as less harmful than cigarettes was associated with a 1.6% point increase in e-cigarette use among U.S. youth (Amrock et al., 2016). A longitudinal study done in the UK with annual waves in 2012, 2013 and 2014 among adults found that perceiving e-cigarettes as less harmful than cigarettes predicted subsequent use of e- cigarettes among respondents who had not previously tried an e-cigarette (Brose et al., 2015). In a recent study done among Appalachian youth 92.3% indicated smoking causes health problems; 83.4% indicated smokeless tobacco causes health problems; whereas only 54.4% indicated e- cigarettes

cause health problems (Mattingly et al., 2020). Moreover, E-cigarette users disagreed that e-cigarette use can cause breathing problems and oral health (Mattingly et al., 2021). A study done in 2014 aimed to describe cigarette harm perception patterns among youth found that approximately one in three students reported that they believed e-cigarettes were less harmful than conventional cigarettes (Ambrose et al., 2014). Tobacco harm perceptions differs greatly by smoking status as described in couple of studies. To illustrate, a recent study showed that individuals who had ever used an e-cigarette were more likely to believe that e-cigarettes are less harmful than traditional cigarettes (Amrock et al., 2015). Moreover, another study have found that a higher proportion of e-cigarette users strongly disagreed that e-cigarettes cause health problems such as breathing and oral health problems compared to never and non-e-cigarette users (Mattingly et al., 2021). Additionally, gender plays a role in tobacco harm perceptions as discussed in previous studies. A couple of studies have found that females were more likely to believe that tobacco products are harmful compared to meles (Ambrose et al., 2014; Amrock et al., 2015; Amrock & Weitzman, 2015). On the other hand, age did not have a clear effect on perceptions of harm toward tobacco products (Amrock & Weitzman, 2015). Mattingly et al. (2021) found that age did not play a significant role in associations between harm perceptions and e-cigarette use.

Summary

Vaping products were invented in 2003 and introduced to the U.S. market in 2006 as aids for smoking cessation and as safer alternative to smoking. Although e-cigarettes were first designed as smoking cessation tool, vaping has become prevalent among middle and high school students. Combustible cigarettes use among youth has declined significantly since the late 1990s, yet the overall nicotine products use has increased due to the presence of e-cigarettes (Fadus et

al., 2019; Hamberger & Halpern-Felsher, 2020). More than 5.2 million young people in the U.S. reported current use of e-cigarettes in 2019, around 28% were high school students and 10% were middle school students (King et al., 2020). E- cigarettes are free from the process of combustion reducing the release of harmful chemicals and carcinogens. For that reason, e-cigarettes are widely perceived to be safer than combustible cigarette. However, there is a growing body of evidence indicating related health risks associated with the use of e-cigarettes. For example, it has been shown that using drugs that contain nicotine during adolescence triggers lasting changes in neuronal signaling and may have potentially severe effects for teen addiction, cognition, and emotional regulation (Yuan et al., 2015). Understanding the impact of e-cigarettes on public health requires consideration of not only the health risks of e-cigarettes on individuals but also the effect of e-cigarettes use on future use of other harmful products such as combustible tobacco cigarettes. Several studies including meta-analysis predict that adolescents' e-cigarettes use can lead to future combustible cigarettes use. Wills and colleagues conducted a study among 9th and 10th grade students in Hawaii and found an association between e-cigarette and smoking among the studied population when they were followed up a year later. Moreover. the perception of e-cigarettes as less harmful than cigarettes was associated with a 1.6% point increase in e-cigarette use among U.S. youth (Amrock et al., 2016). Furthermore, A study done in 2014 aimed to describe cigarette harm perception patterns among youth found that approximately one in three students reported that they believed e-cigarettes were less harmful than conventional cigarettes (Ambrose et al., 2014).

CHAPTER III

Methodology

This study is a secondary data analysis of a nationally representative cross-sectional survey, National Youth Tobacco Survey (NYTS), collected in 2020. The 2020 NYTS used a stratified, three-stage cluster sample design to produce a nationally representative sample of middle school and high school students in the United States. For the 2020 survey, a total of 14,531 students from 180 schools participated in filling the survey. The survey was electronically delivered to students using special tablets and it included 117 questions that took approximately (35-45) minutes to complete. The survey is approved by CDC's Institutional Review Board (IRB). This survey is also listed as one of the exempt studies for designation of non-human subject research for Georgia State University Research administration. The survey's questions revolve around different aspects of tobacco-related indicators such as tobacco use (e-cigarettes, cigarettes, cigars, smokeless tobacco, hookahs); exposure to secondhand smoke and e-cigarette aerosol; smoking cessation; adultescents' ability to purchase tobacco products; knowledge and attitudes about tobacco; and familiarity with pro-tobacco and anti-tobacco media messages. From the 117 questions, only 55 questions will be selected that include questions for the sample demographic characteristics as well as questions that is concerned to answer our research questions. Frequency analysis will be used to describe the sample demographic characteristics. Cross tabulations will be used to compare the perceptions of tobacco-related harm between e-cigarette users, cigarette users, and non-users, between male and female, and between middle school students and high school students among the participants. Moreover, chi-square tests will be used to test the association between the perceptions of peer-related cigarette and e-cigarette use with actual cigarette and e-cigarette use among surveyed youth. All data

collected will be analyzed using SPSS software version 28 and statistical significance will be determined at the level of $p < 0.05$.

Research Questions

5. What is the prevalence of perceptions of tobacco-related harm among youth comparing e-cigarette users, cigarette users, and non-users?
6. What is the prevalence of perceptions of tobacco-related harm between male and female youth?
7. What is the difference in prevalence of the perceptions of tobacco-related harm between older aged youth and younger aged youth?
8. What is the association between the perceptions of peer-related cigarette and e-cigarette use with actual cigarette and e-cigarette use among youth?

Instrumentation

The survey used in this study is the National Youth Tobacco Survey (NYTS) collected in 2020. Tobacco-related indicators included in the NYTS are tobacco use (e- cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, roll-your-own cigarettes, pipes, snus, dissolvable tobacco, bidis, and heated tobacco products); exposure to secondhand smoke and e- cigarette aerosol; smoking cessation; minors' ability to purchase or obtain tobacco products; knowledge and attitudes about tobacco; and familiarity with pro-tobacco and anti-tobacco media messages. Only specific questions that is related to the study objectives was used in this study. The 2020 NYTS employed a stratified, three-stage cluster sample design to produce a nationally representative sample of middle school and high school students in the United States. The survey was administered electronically to students via tablets, absent students on day of survey

administration were allowed to fill a make-up survey via a web-based version of the questionnaire.

Population

This study consisted of a nationally representative sample of middle school and high school students in the United States from all 50 states. The sampling procedures were probabilistic and conducted without replacement at all stages, consisting of the following: Primary Sampling Units (PSUs) (defined as a county, or a group of small counties, or part of a very large county) within each stratum; 2) Secondary Sampling Units (SSUs), (defined as schools or linked schools) within each selected PSU; and 3) students within each selected school. Participation in the NYTS was voluntary at both the school and student levels. At the student level, participation was anonymous. CDC's Institutional Review Board (IRB) requires that parents be given the opportunity to opt their student out of participating in the survey. Schools used either passive or active permission forms at their discretion.

Design

This study is a secondary data analysis of an existing, cross-sectional study of a nationally representative sample of U.S. youth.

Data collection

Data were collected electronically from students through special tablets, data were collected offline using a programmed survey application. The survey took approximately one class period 35-45 minutes to be filled. Survey administration was started on January 16, 2020 and was expected to continue until May 15, 2020. However, data collection was terminated early on March 16, 2020, due to widespread school closures as a result of the COVID-19 pandemic. The survey

used in this study is approved by three bodies: the Office of Management and Budget (OMB), ICF's Institutional Review Board (IRB) and CDC's Institutional Review Board IRB. Georgia State University IRB approval must be obtained to conduct this study.

Data analysis

Descriptive statistics including frequency, percentage, mean, and standard deviation were used to describe the sample demographic characteristics. Cross tabulations were used to compare the perceptions of tobacco-related harm between e-cigarette users, cigarette users, and non-users, between male and female, and between middle school students and high school students among the participants. Moreover, chi-square tests were used to test the association between the perceptions of peer-related cigarette and e-cigarette use with actual cigarette and e-cigarette use among surveyed youth. SPSS program (28 version) was used for data analysis in this study

Measures:

Demographic information included age and gender. Participants' age described in the results as middle school (6th-8th grade) and high school (9th-12th grade), gender (male; female). Current e-cigarette users were defined as someone who has ever used e-cigarettes in their life and has use e-cigarettes at least 2-10 days. Current cigarette users were defined as someone who has used more than 6 cigarettes in their life. Results are classified into the following not mutually exclusive) categories; non-e-cigarette users and non-cigarette users, e-cigarette users, and cigarette users. Perceived relative harm was assessed with several questions and the choices were listed as; (a) no harm, (b) little harm, (c) some harm, and (d) a lot of harm.

CHAPTER IV

This study investigated the prevalence of tobacco-related harm perceptions among youth comparing e-cigarette users, cigarette users, and non-users, and the perceptions of tobacco-related harm between older aged youth and younger aged youth. The study also determined the prevalence of tobacco-related harm perceptions among youth who report e-cigarette use, cigarette use, and non-cigarette/e-cigarette use. Moreover, this study examined differences in tobacco-related harm perceptions among various age groups of youth.

Results:

Results from 14,531 students were analyzed from the 2020 NYTS. Displayed in Table 1 are respondents' beliefs about the harm of e-cigarettes, and traditional cigarettes comparing non-e-cigarette users and non-cigarette users with e-cigarette users, and cigarette users. Opinions of tobacco harm varied markedly by smoking status. Around 46% of non-e-cigarettes users and 42% of non-cigarettes users believed that people harm themselves when they use e-cigarettes some days but not every day, while only 22.2% of e-cigarettes users and 21.7% and cigarettes users believed the same way. These results are similar for respondents' opinions who believed smoking cigarettes some days but not every day cause no harm to people where percentages of non-e-cigarettes users and non-cigarettes users were 51.7% and 49.7% respectively which almost double the percentages of e-cigarettes users 36.8% and cigarettes users 27.1%. Moreover, perceptions about e-cigarettes addictiveness compared to cigarettes differed markedly by smoking status. Non-e-cigarettes users and non-cigarettes users who believed that e-cigarettes are less addictive than cigarettes were 19.8% and 18.2% respectively compared to 7.7% and 9.6% of e-cigarettes users and cigarettes users, respectively. A similar pattern was also observed for the perceptions about the harmfulness of vapor and smoke from other people e-cigarettes and

cigarettes where percentages of non-users who believed the smoke causes a lot of harm were double the percentages of e-cigarettes and cigarettes users (Table 1).

Table 1: Harm perceptions of cigarettes and e-cigarettes based on smoking status

	E-cigarette users (N=2,676)	**Non-e-cigarette users (N=11,855)**	**Cigarette users (N=505)**	**Non cigarette users (N=14,026)**
Believes people harm themselves when they smoke cigarettes some days but not every day				
No harm	115 (4.4%)	257 (2.2%)	38 (7.7%)	334 (2.4%)
Little harm	403 (15.4%)	786 (6.7%)	118 (24%)	1071 (7.7%)
Some harm	1134 (43.4%)	4636 (39.5%)	202 (41.1%)	5568 (40.1%)
A lot of harm	961 (36.8%)	6071 (51.7%)	133 (27.1%)	6899 (49.7%)
Believes people harm themselves when they use e-cigarettes some days but not every day				
No harm	224 (8.7%)	399 (3.4%)	61 (12.6%)	562 (4.1%)
Little harm	762 (29.6%)	1453 (12.4%)	142 (29.4%)	2073 (15%)
Some harm	1017 (39.5%)	4511 (38.5%)	175 (36.2%)	5353 (38.8%)
A lot of harm	572 (22.2%)	5345 (45.7%)	105 (21.7%)	5812 (42.1%)
Believes about addictiveness of e-cigarettes compared to cigarettes				
Less addictive	510 (19.8%)	900 (7.7%)	88 (18.2%)	1322 (9.6%)
Equally addictive	1015 (39.4%)	3792 (32.5%)	194 (40.2%)	4613 (33.5%)
More addictive	847 (32.9 %)	3784 (32.4%)	168 (34.8%)	4463 (32.4%)
I have never heard of e -cigarettes	39 (1.5%)	453 (3.9%)	15 (3.1%)	477 (3.5%)
I don't know enough about these products	164 (6.4%)	2754 (23.6%)	18 (3.7%)	2900 (21.1%)
Not including the vapor from e-cigarettes, do you think that breathing smoke from other people's cigarettes or other tobacco products causes...?				
No harm	182 (7.1%)	475 (4.1%)	50 (10.5%)	607 (4.4%)
Little harm	783 (30.7%)	2576 (22.2%)	153 (32.1%)	3206 (23.4%)
Some harm	1091 (42.8%)	4770 (41.1%)	198 (41.5%)	5663 (41.4%)
A lot of harm	492 (19.3%)	3791 (32.6%)	76 (15.9%)	4207 (30.7%)
Do you think that breathing the vapor from other people's e-cigarettes causes...?				
No harm	649 (25.6%)	1007 (8.7%)	133 (28.2%)	1523 (11.2%)
Little harm	931 (36.8%)	3191 (27.5%)	166 (35.2%)	3956 (29%)
Some harm	723 (28.6%)	4389 (37.9%)	130 (27.5%)	4982 (36.5)
A lot of harm	229 (9%)	3000 (25.9%)	43 (9.1%)	3186 (23.3%)

When comparing harm perceptions between males and females' participants, the prevalence of harm perceptions of cigarettes was similar, and there were no significant differences between the two groups. However, the prevalence of harm perceptions of e-cigarettes was different, as shown in (Table 2). For example, 5.7% of males' participants believed that e-cigarettes are not harmful, while 3% of females believed the same way. Moreover, 13.7% of males believed that the vapor of e-cigarettes is not harmful, while 9.8% of females believed the same way. Additionally, the prevalence of males who believe that e-cigarettes are less addictive than cigarettes was higher compared to females (11.4%, 8.5%) respectively.

Table 2: Harm perceptions of cigarettes and e-cigarettes based on gender

	Males (N=5276)	**Females (N= 5461)**
How much do you think people harm themselves when they smoke cigarettes some days but not every day?		
No harm	215 (3%)	153 (2.1%)
Little harm	653 (9.3%)	531 (7.3%)
Some harm	2796 (39.6%)	2963 (40.7%)
A lot of harm	3389 (48.1%)	3627 (49.9%)
How much do you think people harm themselves when they use e-cigarettes some days but not every day?		
No harm	**399 (5.7%)**	**218 (3%)**
Little harm	1293 (18.4%)	919 (12.7%)
Some harm	2620 (37.4%)	2899 (40.1%)
A lot of harm	**2700 (38.5%)**	**3199 (44.2%)**
Believes about addictiveness of e-cigarettes compared to cigarettes		
Less addictive	**794 (11.4%)**	**612 (8.5%)**
Equally addictive	2174 (31.1%)	2623 (36.2%)
More addictive	2328 (33.3%)	2293 (31.7%)
I have never heard of e-cigarettes	213 (3%)	279 (3.9%)
I don't know enough about these products	1480 (21.2%)	1429 (19.7%)
Not including the vapor from e-cigarettes, do you think that breathing smoke from other people's cigarettes or other tobacco products causes...?		
No harm	364 (5.3%)	289 (4%)
Little harm	1735 (25%)	1620 (22.5%)
Some harm	2714 (39.2%)	3133 (43.5%)
A lot of harm	2116 (30.5%)	2156 (30%)

Do you think that breathing the vapor from other people's e-cigarettes causes...?		
No harm	**943 (13.7%)**	**706 (9.8%)**
Little harm	2045 (29.6%)	2072 (28.8%)
Some harm	2333 (33.8%)	2766 (38.5%)
A lot of harm	1582 (22.9%)	1639 (22.8%)

Comparing prevalence of harm perception between high school students and middle school students showed slightly lower prevalence of harmful perceptions among high school students for both e-cigarettes and cigarettes. However, there is a significant difference in harm perceptions when comparing e-cigarettes to cigarettes. The percentages of students who believe e-cigarettes are safe are higher than those who believe the same way about cigarettes. For example, 8.6% of middle and high school students believed that smoking e-cigarettes cause no harm, while 5.1% believed that smoking cigarettes cause no harm. Moreover, 60% of students believed that the smoke from other people's cigarettes is harmful, while only 46% believed that the vapor from other people's e-cigarettes is harmful.

Table 3: Harm perceptions of cigarettes and e-cigarettes based on age

	Middle school N= 6247	High school N= 4495
How much do you think people harm themselves when they smoke cigarettes some days but not every day?		
No harm	159 (2.3%)	209 (2.8%)
Little harm	520 (7.5%)	667 (9.1%)
Some harm	2675 (38.4%)	3080 (41.9%)
A lot of harm	3618 (51.9%)	3402 (46.2%)
How much do you think people harm themselves when they use e-cigarettes some days but not every day?		
No harm	280 (4%)	337 (4.6%)
Little harm	903 (13%)	1310 (17.9 %)
Some harm	2553 (36.8%)	2964 (40.6%)

A lot of harm	**3210 (46.2%)**	**2696 (36.9%)**
Believes about addictiveness of e-cigarettes compared to cigarettes		
Less addictive	**596 (8.6%)**	**811 (11.1%)**
Equally addictive	2096 (30.3%)	2707 (37%)
More addictive	2191 (31.7%)	2430 (33.3%)
I have never heard of e -cigarettes	314 (4.5%)	174 (2.4%)
I don't know enough about these products	1723 (24.9%)	1185 (16.2%)
Not including the vapor from e-cigarettes, do you think that breathing smoke from other people's cigarettes or other tobacco products causes...?		
No harm	322 (4.7%)	332 (4.6%)
Little harm	1598 (23.3%)	1755 (24.2%)
Some harm	2683 (39.1%)	3165 (43.6%)
A lot of harm	**2264 (33%)**	**2012 (27.7%)**
Do you think that breathing the vapor from other people's e-cigarettes causes...?		
No harm	**611 (8.9%)**	**1042 (14.4%)**
Little harm	1750 (25.5%)	2364 (32.7%)
Some harm	2562 (37.3%)	2535 (35.1%)
A lot of harm	**1946 (28.3%)**	**1280 (17.7%)**

Lastly, A chi-square test of independence showed that there was a significant association between the perceptions of peer-related cigarette use with actual cigarette use among youth χ^2=302.89, df=10, p<0.001. Similarly, there was significant association between the perceptions of peer-related e-cigarette use with actual e-cigarette use among youth χ^2=1885.98, df=10, p<0.001. E-cigarettes users and cigarettes users were more likely to believe that ten out every ten students in their grade use either e-cigarette or cigarettes as explained in (Figure 1) and (Table 4).

Figure 1: Perceptions of number of students who use e-cigarettes by smoking status

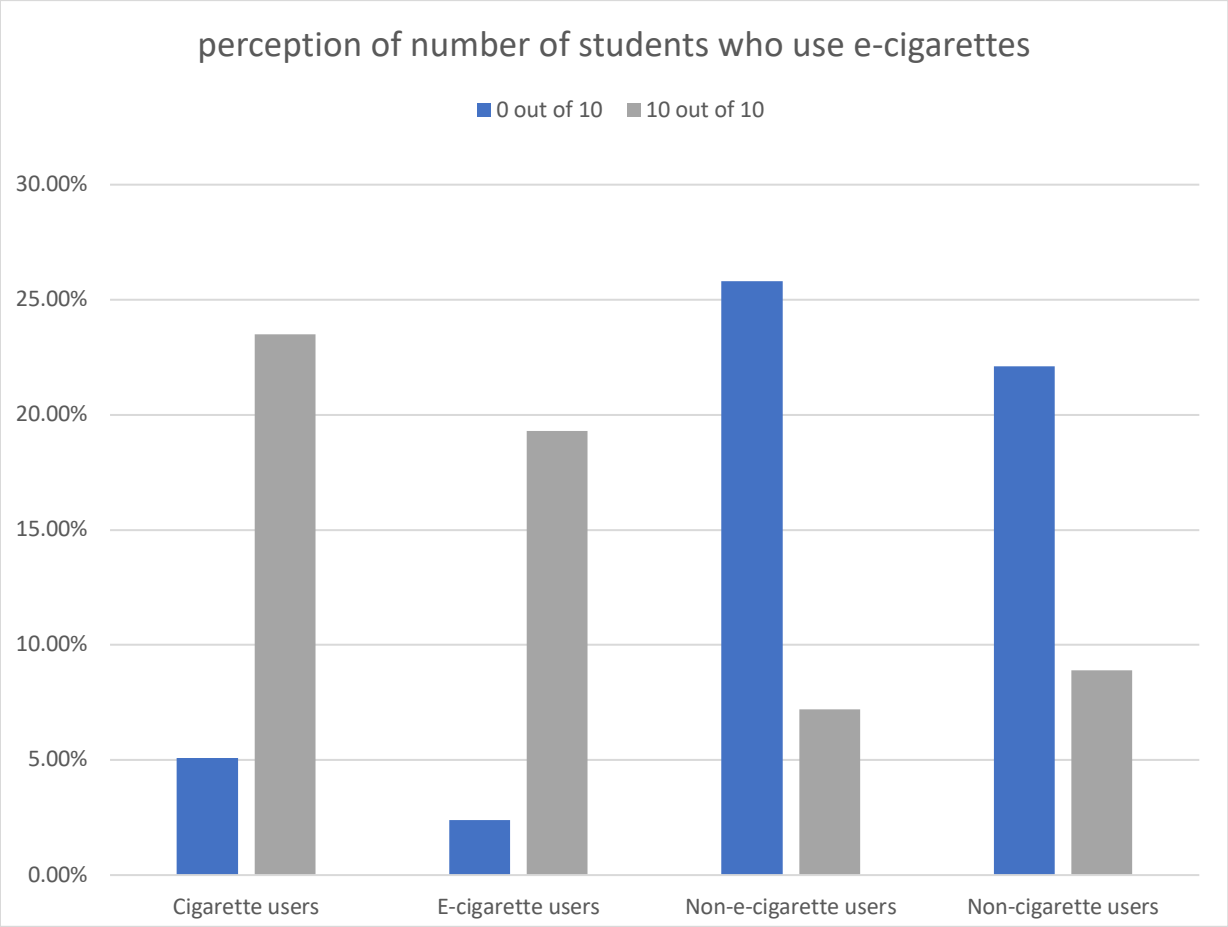

Table 4: Perceptions of peer-related cigarette and e-cigarette by smoking status

	E-cigarette users	Non-e-cigarette users	Chi-square test	Cigarette users	Non-cigarette users	Chi-square test
Out of every 10 students in your grade at school, how many do you think use cigarettes?			χ^2=363.78, df=10, p<0.001			χ^2=302.89, df=10, p<0.001
0	393 (15.1%)	3720 (31.8%)		23 (4.7%)	4090 (29.6%)	
1	533 (20.4%)	2048 (17.5%)		58 (11.8%)	2523 (18.3%)	
2	415 (15.9%)	1519 (13%)		71 (14.4%)	1863 (13.5%)	
3	258 (9.9%)	1124 (9.6%)		56 (11.4%)	1326 (9.6%)	
4	171 (6.6%)	738 (6.3%)		45 (9.1%)	864 (6.3%)	
5	191 (7.3%)	775 (6.6%)		47 (9.5%)	919 (6.7%)	
6	121 (4.6%)	386 (3.3%)		26 (5.3%)	481 (3.5%)	
7	98 (3.8%)	288 (2.5%)		38 (7.7%)	348 (2.5%)	
8	93 (3.6%)	245 (2.1%)		30 (6.1%)	308 (2.2%)	
9	65 (2.5%)	130 (1.1%)		22 (4.5%)	173 (1.3%)	
10	270 (10.4%)	709 (6.1%)		77 (15.6%)	902 (6.5%)	
Out of every 10 students in your grade at school, how many do you think use e-cigarettes?			χ^2=1885.98, df=10, p<0.000			χ^2=376.898, df=10, p<0.001
0	63 (2.4%)	3003 (25.8%)		25 (5.1%)	3041 (22.1%)	
1	60 (2.3%)	1307 (11.2%)		8 (1.6%)	1359 (9.9%)	
2	89 (3.4%)	1044 (9%)		13 (2.7%)	1120 (8.2%)	
3	143 (5.5%)	1034 (8.9)		25 (5.1%)	1152 (8.4%)	
4	189 (7.3%)	977 (8.4%)		23 (4.7%)	1143 (8.3%)	
5	284 (10.9%)	1025 (8.8%)		50 (10.2%)	1259 (9.2%)	
6	263 (10.1%)	693 (6%)		41 (8.4%)	915 (6.7%)	
7	335 (12.9%)	678(5.8%)		52 (10.6%)	961 (7%)	
8	385 (14.8%)	637 (5.5%)		67 (13.7%)	955 (7%)	
9	285 (11%)	397 (3.4%)		71 (14.5%)	611 (4.4%)	
10	500 (19.3%)	835 (7.2%)		115 (23.5%)	1220 (8.9%)	

CHAPTER V

Discussion

This study examined U.S. adolescents' perceptions of harm of e-cigarettes and cigarettes and correlates of those views with students' smoking status, gender, and age. This study also explained the association between the perceptions of peer-related cigarette and e-cigarette use with actual cigarette and e-cigarette use among U.S. youth. Findings of the study indicated that majority of e-cigarettes and cigarettes' users have lower perception of harm towered these products compared to non-users. Around half of the non-users believed that smoking cigarettes and e-cigarettes is harmful, yet less than third of the e-cigarettes and cigarettes users believed that smoking cigarettes and e-cigarettes is harmful. Although the cross-sectional nature of the NYTS survey cannot assess a cause-and-effect relationship between the low e-cigarette harm perceptions and the initiation of e-cigarette use, this study findings consistently show a relationship between perception and use as across all the surveyed youth, the belief that e-cigarettes or cigarettes are safe was higher among e-cigarettes users and cigarettes users compared to non-users. This finding emphasizes adolescents' perception of the safety for whichever product they use as shown in previous studies (Amrock et al., 2015, 2016; Amrock & Weitzman, 2015). A previous study have found that the perception of e-cigarettes as less harmful than cigarettes was associated with a 1.6% point increase in e-cigarette use among U.S. youth (Amrock et al., 2016). Additionally, this study results revealed that the prevalence of harm perceptions among surveyed adolescents was consistently lower for e-cigarettes compared to cigarettes which was also demonstrated in previous studies (Amrock et al., 2015; Brose et al., 2015; El-Amin et al., 2022; Mattingly et al., 2021). The lower harm perceptions of e-cigarettes compared to cigarettes was investigated in couple of previous studies. For instance, recent

studies tested the effect of exposure to e-cigarettes marketing that focus on e-cigarettes being a safer option than cigarettes was one of the main contributing factors for lower harm perception toward these products (Pokhrel et al., 2015; Pu & Zhang, 2017). Moreover, a recent systematic review examined the perceptions and sentiments associated with e-cigarettes on social media platforms concluded that people's perceptions and sentiments about e-cigarettes were more positive than negative on social media (Kwon & Park, 2020). This might explain the lower perceptions of harm toward e-cigarettes as social media is widely accessible to almost all teens these days. This study findings reinforce the need for continued education about the long- and short-term effects of using e-cigarettes especially the nicotine addiction and the possible future traditional cigarettes use. Recent studies have found that adolescents who use e-cigarettes are more likely to use conventional cigarettes in the future (Akre & Suris, 2017; Fadus et al., 2019). Additionally, this study findings corroborate previous researches that described gender effect on harm perceptions of tobacco as perceiving e-cigarettes as less harmful was common among males' participants more than females' participants (Ambrose et al., 2014; Amrock et al., 2015; Amrock & Weitzman, 2015). Specifically, in current analysis differences were noted in harm perceptions of e-cigarettes as prevalence of male's participants who believed that e-cigarettes are not harmful was double the prevalence of females who believed the same way. The second goal of this study is to assess how the perceptions of peer-related cigarette and e-cigarette use were associated with actual cigarette and e-cigarette use among youth. Cigarette and e-cigarette use was associated with increased perception of number of students who use cigarettes and e-cigarettes. E-cigarettes users and cigarettes users were more likely to believe that ten out every ten students in their grade use either e-cigarette or cigarettes. The results show a tendency for adolescents to falsely perceive peer tobacco use rates in a direction consistent with their own use

or non-use. These results are consistent with a false consensus effect, also known as "normative fallacy" in which adolescents substance users' overestimate use among their peers and non-users' underestimate their peer use (Henry et al., 2011). Research by Cunningham and Selby (2007) found that almost three fourths of young adult smokers overestimated the prevalence of smoking among their peers by more than 20%.

Limitations

The present study has several limitations. First, due to the cross-sectional nature of the present study, causality cannot be established. Future research should examine how harm perceptions is associated to initiation and use of e-cigarettes in longitudinal studies. Second, data used in this study is self-reported which might lead to social desirability bias and recall bias.

Conclusion

This study provides a more in-depth examination of harm perceptions related to e-cigarettes and cigarettes than found in previous studies. Prevalence of tobacco harm perceptions among youth who use e- cigarettes or cigarettes are less compared with non-e-cigarette and non-cigarette users. Moreover, e-cigarettes users and cigarettes users were more likely to overestimate the number of students who use e-cigarettes or cigarettes. Addressing harm perceptions may be important to increase awareness of long- and short-term effects of using e-cigarettes especially the nicotine addiction and the possible future traditional cigarettes use and ultimately reduce e-cigarette use among adolescents.

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