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Examining the Relationship between the Use and Awareness of Alternative Tobacco Products and Smoking Quit Attempt among U.S Adolescents.

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Examining the Relationship between the Use and Awareness of Alternative Tobacco Products and Smoking Quit Attempt among U.S Adolescents.

by

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B.Sc., University of the West Indies, Jamaica.

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ABSTRACT

Introduction: Public health interventions have heightened awareness of risk factors and ill effects of tobacco use. Though sales of conventional tobacco products have steadily been declining, there is the advent of a new generation of alternative tobacco products that are being marketed with claims of reduced harms and smoking cessation aid.

Aim: The aim of this study is to assess the prevalence of tobacco quit attempt among U.S. adolescents and to examine its relationship to the use and self-reported awareness of two alternative tobacco products (E-cigarettes and Heated Tobacco Products).

Methods: This is a cross-sectional analysis of data (2,271) from the 2019 National Youth Tobacco Survey (NYTS) of middle and high school students in the U.S. Logistic regression analysis was employed to determine the odds of tobacco quit attempt adjusting for age, race, gender, school type, and household tobacco exposure.

Results: The overall prevalence of tobacco quit attempt among e-cigarette users and HTP users was 52.50% and 5.20%, respectively. Results of multivariate regression analyses identified age (OR=0.74, 95% CI:0.57-0.96), race (OR=1.41, 95% CI:1.14-1.75), and household tobacco smoke exposure (OR=1.19, 95% CI:1.01-1.39) as the main factors that are significantly associated with tobacco quit attempt adjusting for all other covariates.

Conclusion: The results of this study did not show a statistically significant association between the awareness and use of e-cigarettes and heated tobacco products and tobacco smoking quit attempt. Race, age, and exposure to household tobacco smoking were found to be positively associated with quit attempts. Further studies are needed to clarify whether the use and awareness of e-cigarette and HTPs are associated with smoking quit attempt.

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Products and Smoking Quit Attempt among U.S Adolescents.

by

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TABLE OF CONTENTS

List of Tables

List of Figures

CHAPTER I: INTRODUCTION

Tobacco smoking has led to over 3 million deaths per year worldwide and 400,000 deaths per year in the U.S alone (McGoldrick & Boonn, 2010). Today, it remains the leading cause of preventable death and disability in the US (Ahluwalia et al., 2018; Shete & Wilkinson, 2017). According to Vangeli et al. (2011), the life expectancy for smokers is reduced by three months for every year they continue to smoke over the age of 40 (Vangeli et al., 2011). National anti-tobacco campaigns and other impactful public health interventions have led to increased awareness of tobacco smoking's ill effects. Consequently, there has been a reduction in the sale and prevalence (Kahende et al., 2011; T. W. Wang et al., 2019) of traditional combustible tobacco products (c-cigarette). However, while cigarette sales have declined, there is the emergence of a new generation of tobacco products (Kinnunen et al., 2015; Lempert & Glantz, 2018). Marketing expenditures for alternate or non-conventional tobacco products have increased (Messer et al., 2015). These include products such as electronic cigarettes (e-cigarette) and Heated Tobacco Products (HTPs) (Marynak et al., 2018) that are increasing in prevalence and popularity among smokers (Malas et al., 2016).

E-Cigarettes are a type of Electronic Nicotine Delivery System (ENDS) created to mimic the sensory experience of smoking traditional combustible cigarettes by vaporizing a liquid mixture that consists of propylene glycol, glycerin, flavorings, nicotine, and other chemicals (Zhong et al., 2016). They are vastly being marketed with claims of smoking cessation (Kinnunen et al., 2015) and have become very popular among adolescents. Nicotine affects the developing brains of adolescents and increases the likelihood of addiction. Also, there are adverse health effects of the toxic impurities in e-

cigarette cartridges; the full extent to which these products affect the health of adolescents are still unknown (Chapman & Wu, 2014)

E-cigarette use among youth poses a significant risk to public health. In 2018, 3.05 million high school students (19.3% increase) in the United States were current e-cigarette users (Gentzke et al., 2019). This was an increase from 1.5% in 2011 to 20.8% in 2018. A similar trend was observed among middle school students with an increase in e-cigarette use from 0.6% in 2011 (60,000 students) to 4.9% (570,000 students) in 2018 (Cullen & Ambrose et al., 2018). The vast array of e-cigarettes has attracted young people's attention as they are available in various flavors, shapes, and colors (Kinnunen et al., 2015). Like e-cigarettes, Heated Tobacco Products (HTPs) have been introduced into the US market. Several concerns have been raised about the impact of these non-traditional tobacco products on youth (B. Wang et al., 2014). Heated Tobacco Products, also referred to as "Heat-not-burn" tobacco products, are a diverse class of non-conventional (alternative) tobacco products that is increasing in popularity within the adolescent population. Similarly to e-cigarettes, HTPs utilize a mechanism whereby heat is used to volatile nicotine to a point below combustion (Czoli et al., 2020), resulting in the production of an aerosol as opposed to burning, which produces smoke; an example of these include Ploom, IQOS (Dunbar et al., 2020). These products differ from e-cigarettes in that e-cigarettes heat nicotine in a liquid solution while HTPs heat cigarette-like tobacco sticks. According to Kwon et al (2018), HTPs may be enticing to youth as they are being advertised and marketed with claims of reduced harm. Tobacco companies use persuasive messages that influence the belief that HTPs are more socially acceptable compared to traditional/combustible cigarettes (Lempert & Glantz, 2018).

Though various versions of HTPs have been around for years, giant tobacco companies have recently started to market new generation HTPs as alternatives to traditional combustible cigarettes (c-cigarettes). Recently, the U.S. FDA authorized Altria in April of 2019 to market IQOS in the U.S. Effective October of 2019, this HTP product was introduced into the U.S market and is being sold in a few stores in Atlanta, Ga as a pilot (Dunbar et al., 2020). Presently, only a few studies have examined the correlations between HTPs and demographic characteristics (Dunbar et al., 2020).

Results of a study conducted by Marynak et al (2018) revealed that 5.2% of the adult population in the US were aware of heated tobacco products and less than 1% reported ever use of HTPs (Marynak et al., 2018). These first estimates among U.S. adults can serve as a critical baseline measure. The impact that electronic cigarettes (e-cigarettes) and heated-tobacco-products (HTPs) have on youth remains a controversial public health problem as it still remains unclear whether alternative (non-conventional) products will lead to an uptick in the use of such products or smoking (Tan & Bigman, 2014). From a public health perspective, this knowledge can be instrumental in framing intervention efforts targeting this specific population. Interventions may focus on parental or guardians' knowledge of e-cigarette and HTPs; this new knowledge may also serve as a foundation for advocating for changes to national e-cigarette and HTP accessibility, regulations, and policies.

There are several reasons why e-cigarettes are increasingly being used by smokers, one of which includes an attempt to quit traditional combustible tobacco smoking; another is to use nicotine in settings where tobacco smoking is disallowed (Kalkhoran & Glantz, 2016). It is also widely viewed, especially among adolescents and teens, that there are no side effects to smoking an e-cigarette (Menakuru & Inzamam Ali, 2018).

In 2016, the FDA finalized a rule that grants regulatory authority over all tobacco products, including all types of Electronic Nicotine Delivery Systems (ENDS) (Lichtenberg, 2017). E-cigarettes may be beneficial if they reduce smoking rates or the myriad of adverse health effects associated with traditional tobacco smoking. Conversely, they may be harmful to youth if they inhibit adolescent smokers from quitting tobacco smoking or increasing the likelihood that nonsmokers or former smokers will begin to use combustible tobacco products (Brandon et al., 2015).

Within the public health community, there have been arguments about the viability of e-cigarettes to reduce harm or be used by smokers to supplement or truly substitute their smoking with e-cigarettes merely and successfully attain smoking cessation (Tan & Bigman, 2014). The decision to use e-cigarette as a smoking cessation intervention among youth remains conflicting; previous studies report inconsistent findings. In 2016, Kalkhoran & Glantz found that the odds of quitting tobacco smoking were 28% lower among e-cigarette users compared to non-e-cigarette users. One study conducted by Kinouani et al. (2017) found that attempts to quit tobacco smoking were reported more by e-cigarette users than any other smoking group. However, results from a comparative study of the differences and similarities of e-cigarette use among adolescents vs. adults showed that among young adults, e-cigarette use was not consistently associated with attempting to quit tobacco smoking (Chapman & Wu, 2014). Results from a six-month follow-up study by Pasquereau et al. (2017) revealed that tobacco smokers who concurrently use e-cigarettes are more likely to attempt to quit at least seven times. Whether these factors pose a barrier to quitting among youth remains unknown. Based on a literature review, there is a scarcity of studies done to examine this phenomenon. This

study adds to the limited body of research assessing the relationship between tobacco quit attempt and alternative tobacco product use among the U.S. adolescent population.

Marketing claims of tobacco companies about the reduced harms and smoking cessation aids of alternative tobacco products still lack evidence of the benefits. Whether the use and awareness of these products are significantly associated with smoking quit attempt among youth remains unclear. Notably, the use of non-conventional tobacco products is increasing in popularity and prevalence (CDCTobaccoFree, 2020b) among youth in the U.S (B. Wang et al., 2014). This has significant public health implications and is therefore imperative that all factors that: 1) Present a barrier to smoking cessation within this vulnerable population are identified and 2) Examined in an effort to implement appropriate, targeted intervention(s) aimed at reducing the prevalence of use and increasing the number and success of quit attempt among youth.

Analyzing cross-sectional data from the 2019 National Youth Tobacco Survey (NYTS), the aim of this study is to assess the prevalence of tobacco quit attempt among U.S. adolescents (Middle and High school students) and to examine the relationship between alternative tobacco product use and awareness to attempts to stop tobacco smoking.

Various models have been developed to study and understand tobacco use behaviors among adolescents. The ecological framework is one that is most used when addressing this issue (DiNapoli, 2009). According to DiNapoli (DiNapoli, 2009), adolescence is a period of transition, during which many choices are made, which can have negative implications on their health and safety. One primary choice is the decision to smoke tobacco products. Siqueira et al. (2001) reported that 75% of

adolescents who chose to use tobacco believe they will quit; however, most still smoke five years later. This study model provides a practical approach to exploring this problem, identifying risk factors, and providing a platform for implementing robust policy change. Additionally, this study sought to add to a growing body of evidence on youth tobacco-related research and bridging the gap in the literature.

1.1 Research Questions

This study will analyze cross-sectional data from the 2019 National Youth Tobacco Survey (NYTS), and the primary aim is to assess the prevalence of tobacco quit attempt among U.S. adolescents (Middle and High school students) and to examine the relationship of alternative tobacco product use and awareness to smoking quit attempt. This study will address the following research questions: 1) Are adolescent e-cigarette users and those who are aware of the addictive properties of e-cigarette more likely to attempt to quit tobacco smoking? 2) Are sociodemographic characteristics associated with tobacco quit attempt?

Other questions that this study will answer include:

- What is the prevalence of e-cigarette use among middle and high school students in the U.S.?

- What is the prevalence of HTP use among middle and high school students in the U.S.?

- Which age group has the highest prevalence of tobacco quit attempt?

- What is the most common age of initiation of e-cigarette use?

- Is there a relationship between the use of e-cigarettes and smoking quit attempt?

- Is there a relationship between the use of HTTPS and smoking quit attempt?

- Is there a relationship between the self-reported awareness of e-cigarette or HTPs and tobacco smoking quit attempt?

- What is the rate of tobacco quit attempt among different racial/ethnic groups?

CHAPTER II: REVIEW OF THE LITERATURE

2.1 Socio-demographic factors relating to heated tobacco and e-cigarette use

Several concerns have been raised about the impact of non-traditional tobacco products on youth. Among these concerns are the risk of developing nicotine addiction, the adverse effects of nicotine on the developing brain of adolescents, and the effects of the toxic constituents of these products (B. Wang et al., 2014). In 2012 E-cigarette was the second-highest used non-conventional tobacco product; hookah was the first. In 2019, e-cigarettes were cited as the most commonly used tobacco product among high school (27.5%) and middle school (10.5%) students (T. W. Wang et al., 2019). Overall, awareness of non-traditional tobacco products was higher among high school students (71.6%) compared to middle school students (55.5%). There were similar e-cigarette awareness levels among both males and females (B. Wang et al., 2014). However, awareness among middle school students was 40.8% and 57.6% among high school students. Findings from the 2014 study revealed that awareness was highest among non-Hispanic white students compared to non-Hispanic Blacks, who had the lowest awareness of e-cigarette (B. Wang et al., 2014). However, findings from a recent study

that looked at the awareness and use of HTPs among US youth showed that Hispanic whites reported being more aware of HTPs (OR=13.0, 95% CI:10.8-15.2) than non-Hispanic Black students (OR=12.2 95% CI:10.8-13.5) and high school students were less likely to report having heard of HTPs compared to middle school students (Dai, 2020). In 2017, 22,275 students in grades 7–9 (age 12–15) and 42,142 in grades 10–12 (age 15–18) nationwide were surveyed (Kuwabara et al., 2020) and overall, 1.8% were current users of any tobacco products over the last month . Multivariable analysis revealed that risk factors for alternative product use were the same as those for a cigarette (Kuwabara et al., 2020). Xiao Zhang et al (2016), examined the association between secondhand tobacco smoke(SHS) exposure at home and e-cigarette use and the mediating effects of SHS exposure in the association between family smoking status and e-cigarette use among adolescents. The results of that study showed that household smoke exposure matters; there was a 23.9% prevalence of e-cigarette use among adolescents living with other smokers and a 16.5% prevalence among those with exposure to SHS at home during the past seven days. Age and gender are important sociodemographic characteristics that may correlate with making an attempt to quit smoking. Abrantes et al (2009), conducted a study that examined youth risk behaviors in relation to making a smoking quit attempt. Results of that study revealed no significant association between smoking quit attempt and the following factors- age, gender, grade level, and ethnicity. The results revealed that adolescents who smoked their first cigarette before age 13 were less likely to make a quit attempt than those who smoked after age 13.

Similarly, Vangeli et al (2011) examined the predictors of smoking quit attempt and cessation success in adults' general population. Results of that study indicated that from the pooled analysis of eight studies examining gender, there is no association between gender and making an attempt to quit smoking (OR = 1.13, CI: 95% CI:0.99–

1.30). Overall, results of that study suggest that socio-demographic factors are not predictive of a quit attempt. The age at initiation of tobacco smoking may be a predictor of smoking duration and smoking cessation attempt. Yi, Yeo-Jin et al (2011) explored the Influences of Demographic, Smoking, and Smoking Cessation Factors on Smoking Cessation Success in Adolescent Smokers. The results from that study showed no association between first smoking age and success for smoking cessation (OR=1.06, 95% CI:0.94-1.21).

2.2 tobacco quit attempt/cessation

Reducing adolescent tobacco smoking prevalence by approximately 26% would result in an annual savings of 100,000 lives and 1.6 million years of human life (Marshall et al., 2016). According to Mantey et al (2017), one primary aspect of comprehensive tobacco control is tobacco smoking cessation, which significantly lowers the risk of tobacco-related morbidity and mortality. Though e-cigarettes are marketed and often used as motivation for smoking cessation, results from a systematic review of electronic cigarettes as smoking cessation devices reveal that there is no sufficient evidence in support of the effectiveness of e-cigarettes as a smoking cessation device (Malas et al., 2016). There are emerging studies and literature aimed at determining the effectiveness of e-cigarette as a smoking cessation device. Results from a longitudinal study that examined the relationship between e-cigarette use and subsequent tobacco smoking cessation reveal that e-cigarette use for cessation was associated with increased odds of smoking cessation at 6 and 12 months follow up compared to non-users of e-cigarette (Mantey et al., 2017). This result was homogenous with findings from a study that examined the Relationship of E-Cigarette Use to Cigarette Quit

Attempts and Cessation which showed that quit attempts were more likely among those with an increased use of e-cigarette(Levy et al., 2018).

To date, only a few studies have been done to examine the correlates of HTPs and demographic characteristics (Dunbar et al., 2020). Results from a 2015 study suggested a different pattern from the marketing claims of the efficacy of e-cigarettes as a smoking cessation device. There was a higher prevalence of e-cigarette use among smokers who were least interested in quitting tobacco smoking (Kinnunen et al., 2015). Kalkhoran & Glantz (2016) reported a similar result for the adult population. The 2016 study assessed the association between the use of e-cigarette and cigarette smoking cessation. Results showed that among e-cigarette users, there was a 28% lower odds of quitting as compared to non-e-cigarette users (OR=0.72, 95% CI:0.57-0.91). Certain demographic groups are disproportionately at risk of severe consequences associated with tobacco use (Stahre et al., 2010). Tobacco quit attempt may vary among races. Traditionally, tobacco use was associated with appetite suppression, the belief that weight gain proceeds cessation may be a risk factor for increase use and decreased attempts to quit (Li et al., 2018). According to   Chithambo & Huey (2013), black women are not subject to the media ideals that promote a slender body image, and white women are vulnerable to media-driven advertisements relating to body dissatisfaction.

2.3 Self-reported awareness and use of E-cigarette

There is a misconception about e-cigarette use; the view that e-cigarettes are more socially acceptable and less risky in comparison to combustible cigarettes has contributed to their increased use among youth (Fadus et al., 2019). In a cross-sectional study of high school students in North Carolina, Anand et al (2015) reported that the

majority of respondents (77.3%) were aware of e-cigarettes and most heard about them via television advertisements (53.2%). Sutfin et al (2013) conducted a study to identify the correlates of e-cigarette use and to estimate the prevalence of use among US young adults and found that e-cigarette use was not significantly associated with quit attempt and intention to quit. Another notable finding of this study is that 12% of e-cigarette users had never smoked a conventional cigarette or any other tobacco product .

2.4 Social and physical environments

In a recent report by the CDC, e-cigarette use has surpassed that of traditional combustible cigarettes. Youth are more inclined to use tobacco products if they are exposed to peers or a parent using these products (CDC, 2019). Secondhand tobacco smoke exposure (SHSe) is a significant health issue. According to Okoli & Kodet (2015), an estimated 40% and 34% of children and non-smoking adults, respectively, are exposed to SHS. This has given rise to over 600,000 deaths from the outcome of secondhand tobacco smoke exposure (SHSe). In 2015, a systematic review examining "the association between secondhand tobacco smoke exposure (SHSe) and smoking behaviors" was conducted by Okoli & Kodet (2015). Smoking cessation was one behavior that was assessed in 10 studies; results from that review indicate that SHSe was significantly associated with an attempt at smoking cessation, though they were unsuccessful attempts (Okoli & Kodet, 2015). According to the Centers for Disease Control and Prevention (CDC), children and teens are three times more at risk of SHSe compared to adults (CDCTobaccoFree, 2020a).

The mass media, including social media, advertisements, and magazines have portrayed the use of tobacco products as normal activities that have appealed to young people and contributed to an increase in their use (CDCTobaccoFree, 2020b). According

to Dunbar et al. (2020), in a study that examined the Correlates of Awareness and Use of Heated Tobacco Products in a Sample of US Young Adults, strategies used to market new generation HTPs may specifically appeal to youth and young adults. Results from that study revealed that only 6% of respondents with no prior history of using other tobacco products reported awareness of HTPs, and only 3% reported ever trying HTPs. There was a positive association between the use of any other tobacco products and awareness of HTPs. Among individuals who are "tobacco-naïve," use and awareness of HTPs were low, and there was no association between smoking cessation and factors related to HTP awareness or use.

2.5 HTP awareness and use

Being aware of the harms or benefits of a product can determine the likelihood of use and the context in which the product is used. New generation HTPs are marketed as Modified (Reduced) Risk Tobacco Products (MRTP). In the U.S, according to Lempert & Glantz (2018), HTPs fall under the FDA's definition of tobacco products and are subject to regulations that apply to the marketing of all tobacco products. Data presented by the manufacturer of HTPs (IQOR) to the FDA consistently failed to demonstrate that the products were beneficial to a reduced risk of harm to humans, compared to traditional combustible cigarettes. Choi et al (2018), investigated the prevalence of HTP use and its association to cigarette quit attempt among adolescents in Korea one year after it was introduced into the Korean market. The study's main findings showed that the use of HTPs is not associated with cigarette quit attempt (OR= 1.07, 95% CI: 0.91-1.26). Results also showed that the prevalence of HTP was 2.8%, which was higher than that of e-cigarette (0.5%) when the prevalence of e-cigarette was assessed one year after its

introduction. A later study showed that after 3 years the prevalence of e-cigarette increased by 20 folds to 9.4%. On this premise, faster expansion of HTP is projected.

Similarly, a two year follow up study in Japan indicated that the prevalence of HTP is increasing. At baseline (2015), only 0.3% of respondents were current users of HTP, while current e-cigarette users were 1.3%. However after 2 years, the prevalence of HTP use increased to 3.6% while e-cigarette use marginally increased to 1.9% (Tabuchi et al., 2016). Nyman et al (2018), "examined the extent of the awareness and use of HTP and assessed the characteristics of those who are aware of and using HTP." Results of that study showed that HTP use increased from 1.4% -2.2% (n=88 to n=144), and HTP awareness increased from 9.3% to 12.4% (n=560 to n=730) among adults in the U.S. between 2016 and 2017. However, HTP use was not significantly associated with cigarette quit attempt.

CHAPTER III: METHODS AND PROCEDURES
3.1 Data source

The National Youth Tobacco Survey (NYTS) is an annual voluntary school-based, self-report cross-sectional survey designed to investigate tobacco-related beliefs, attitudes, behaviors, and exposure to pro-and antitobacco influences among public middle school (grades 6–8) and high school (grades 9–12) students. The year 2019 was the first year the survey was administered in schools using tablet computers. Participating schools determined whether parental consent would be received actively, whereby parents provided written permission allowing their child to participate in the survey, or passively, whereby parents signed and returned the permission form only if they did not want their child to participate in the survey. Parental consent and respondent assent were obtained for all participants (Gentzke et al., 2019).

3.2 Sample selection

A three-stage cluster sampling procedure was used to generate a nationally representative sample of U.S. students attending public and private schools in grades 6–12 (Gentzke, A. S. et al, 2019). The primary sampling unit, as defined by the CDC, is a county, a group of small counties, or part of a very large county and were selected at random within each stratum. Secondary sampling units, which included schools within each selected PSU, were selected randomly within each PSU (Dai, 2020). At the final sampling stage, classes were selected at random within each school. Student Participation in the 2019 NYTS was voluntary and anonymous, required parental consent and student assent. From the final sample of 325 schools in 2019, 251 participated, yielding a school response rate of 77.2% (or refusal rate of 22.8%) (Dai, 2020). From a sample of 22,153 students, the total number of student questionnaires completed was 19,018, yielding a student response rate of 85.8% and an overall response rate of 66.3% (Dai, 2020). Race and ethnicity were separately assessed by self-report with fixed category response options (Cullen et al., 2019). Students could select one or more of the following categories for the race: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, or White. Students could select whether they were Hispanic, Latino, Latina, or of Spanish origin. The National Youth Tobacco Survey (NYTS) was approved by the institutional review board of the US Centers for Disease Control and Prevention (CDC). In 2018, a pilot survey of the NYTS was conducted using two electronic versions, one programmed to align with the paper-based survey and the other to take advantage of electronic administration, including programmed skip patterns and tobacco

product images (Hu, S.S. et al, 2020). Minimal differences in tobacco product use estimates were observed between the two electronic pilot survey versions in 2018 (Hu, S.S. et al, 2020). The number of participants included in the 2019 dataset was 19,018, and there were 421 variables. A detailed description of the 2019 NYTS survey design, questionnaire, and data collection can be found at https://www.cdc.gov/tobacco/data_statistics/surveys/nyts/index.htm

3.3 Data Collection procedure

The first time the survey was conducted electronically was in 2019; from 1999-2018, the survey was conducted using a paper and pencil questionnaire. The 2019 data collection period span February 15, 2019, to May 24, 2019; during that time, a survey application was used to collect data offline that was loaded onto an electronic tablet (Cullen et al., 2019). Students absent on the day of survey administration could participate using a web-based version of the questionnaire, which was programmed to mimic the tablet-based application. Skip patterns were programmed in the 2019 questionnaire to reduce respondent burden (Gentzke, A. S. et al, 2019). This is a secondary analysis of publicly available, de-identified data; therefore, no ethics approval was sought.

3.4 Definition and measures

- **E-Cigarette** use was defined as using an electronic cigarette on at least one day in the entire lifetime.

- **Self-reported awareness of e-cigarette** was assessed by the following "Do you believe that e-cigarettes are (LESS ADDICTIVE, EQUALLY ADDICTIVE, or MORE ADDICTIVE) than cigarettes? Options for answers were: Less addictive, equally addictive, more addictive, I have never heard of e-cigarettes, and I don't know

enough about these products. Those who chose an option other than "I have never heard of e-cigarettes" were classified as being aware of E-cigarettes.

- **Attempt to quit** was defined as selecting (1) or more times to the question: 'During the past 12 months, how many times have you stopped using all tobacco products for one day or longer because you were trying to quit all tobacco products for good?

- **Attempt to quit** smoking tobacco products was dichotomized as yes or no based on students' responses to the previous question. Those who selected one or more times were categorized as "yes," and those who chose the answer "I did not try to quit all tobacco products during the past 12 months" were categorized as "no." Students who legitimately skipped the question were excluded.

- **Heated Tobacco Products (HTPs) self-reported awareness and use of HTPs** were assessed by the questions respectively 'Before today, have you ever heard of heated tobacco products? Have you ever tried a "heated tobacco product" even just one time?

3.5 Statistical Analysis

Factors associated with tobacco quit attempt were analyzed using logistic regression analyses. The analyses were separately conducted for E-cigarette and HTPs. In the descriptive statistics, the frequency distribution was reported to describe the characteristics of the population. A bivariate analysis was performed to obtain the crude odds ratio (OR)for examining the relationship between all variables in the study and tobacco quit attempt.

Separate multivariate logistic regression analyses were conducted for e-cigarette and HTPs. Four (4) models were estimated in the multivariate regression analyses for

each of the study's alternative tobacco products. For e-cigarette, in the first model, tobacco quit attempt (the dependent variable) was modeled with socio-demographic factors (age, race, gender, school type, age at initiation of e-cigarette). In the second model, e-cigarette use was added to the model. In the third model, e-cigarette use was substituted with self-reported awareness (of the addictiveness of e-cigarette). In the final model, both E-cigarette use and self-reported awareness of the addictiveness of e-cigarette were added. The analyses were repeated for HTPs. Results were presented in the form of Odds Ratios (OR) and their confidence intervals (CI). The weight, stratum, and primary sampling units (PSUs) variables provided in the public dataset were incorporated when performing analyses. All statistical data analyses were done with SAS 9.4 and R 1.3.

3.6 Description of Variables

3.6.1 Dependent Variable

In this study the dependent variable was tobacco quit attempt dichotomized as "yes" or "no."

3.6.2 Independent Variables

The main independent variables of this study were assessed as binary outcomes. They include:

a. E-cigarettes use

b. Self-reported awareness of the addictiveness of e-cigarette

c. HTP use

d. Self-reported awareness of HTP

Other covariates included sociodemographic variables such as:

a. Age- categorized as 9-12, 13-15, 16-17, and 18+ as used in a study by (Dai, 2020)

b. Gender—categorized as male and female

c. Race/ ethnicity- grouped into four categories, Black/African American, non-Hispanic White, Hispanic and Other

d. School type (Middle and High school)

e. Age at initiation of e-cigarette

f. Household exposure to tobacco smoking

CHAPTER IV: RESULTS

A total of 19,018 students participated in the survey. From this sample, 2271 attempted to quit tobacco smoking within the past 12 months, 18,096 (96. 75%) have heard of E-cigarettes before and aware of its addictive nature. A total of 6,356 (33.42%) have used e-cigarette on at least one day in their lifetime. There was a total of 2390 (12.57%) and 398 (2.34%) respondents who had heard of HTP before and used HTP, respectively. Overall, 52.50% of ever user of e-cigarette attempted to quit tobacco smoking within the past 12 months, and the prevalence of HTP use among respondents who attempted to quit tobacco smoking within the past 12 months was 5.20%.

4.1 Description of the sample population

Table 1 shows the socio-demographic characteristics of respondents in the entire sample. Of the total number of respondents (19,018), 50.74% were non-Hispanic White, 24.38% were Hispanic, and 12.33% were Black or African American. The majority of respondents (55.92%)were in high school and between 13-15 years of age 44.42%. The

prevalence of household tobacco smoke exposure within the past seven days was 25.28%. Approximately 97% of respondents were aware of the addictive effect of e-cigarettes, and 34.66% have used an e-cigarette on at least one day in their entire life. There was a significantly larger proportion of e-cigarette users (34.7%) compared to HTP users (2.61%), and only 16.52% of respondents have heard of HTP.

Table 1: Sample Characteristics of Middle and High School Students in the United States, by Selected Demographic Variables-NYTS 2019.

Demographic Characteristics	Frequency	Weighted % (95% CI)
Age in years n=**18,980**		
9-12	3,951	19.200(17.131-21.269)
13-15	8,481	44.420 (42.656-46.185)
16-17	5,050	27.883 (25.437-30.328)
18 years or older	1,498	8.497 (7.463-9.532)
Race/Ethnicity n=**19,018**		
Black/African American	2,288	12.334 (9.674-14.994)
Hispanic	5,564	24.376 (21.312- 27.441)
Non-Hispanic White	8,536	50.737 (46.451-55.022)
Other††	2,630	12.553 (11.055-14.051)
Gender n=**18,902**		
Male	9,803	52.043 (50.393-53. 693)
Female	9,099	47.957 (46.307- 49.607)
School Type n=**18,934**		
Middle	8,837	44.081 (39.779-48.383)
High	10,097	55.919 (51.617-60.221)
Household Tobacco smoke exposure n=**18,613**		
Yes	4,586	25.280 (23.336-27.224)
No	14,027	74.720 (72.776-76.664)
E-cigarette use n= **19,018**		
Yes	6356	34.657 (32.536 - 36.779)
No	12662	65.343 (63.222 - 67.465)
E-cigarette awareness n= **18,704**		
Yes	18096	96.993 (96.577- 97.408)
No	608	3.008 (2.592 - 3.423)
HTP use n= **17,031**		
Yes	398	2.612 (1.641 - 3.583)
No	16633	97.388 (96.417-98.359)
HTP awareness n= **14,550**		
Yes	2390	16.520(15.010- 18.030)
No	12160	83.480 (81.970- 84.990)

Note: Row percent used, Unweighted frequency reported. Other †† (American Indian or Alaskan, Asian, Native Hawaiian or other Pacific Islander).
Middle school (Grades 6-8) High School (Grade 9-12).

4.2 Bivariate logistic regression Results

Table 2 shows the unadjusted odds of tobacco quit attempt for each of the study variables using bivariate logistic regression. As compared to respondents who were 13-15 years old, the odds of tobacco quit attempt were highest among adolescents between the ages of 9 and 12 (OR=1.25, 95% CI: 0.897-1.754); this association was not statistically significant. Adolescents within all other age groups had lower odds of attempting to quit smoking compared to those aged 13-15 (see Table 2). Age group 16-17 (OR=0.76, CI: 0.636-0.911) or 18 years or older (OR =0.79, 95% CI: 0.635-0.974) was a protective factor against tobacco quit attempt. Adolescents in the age group 16-17 had 0.76 times lower odds of attempting to quit smoking compared to those in the 13-15 age group (OR=0.76, CI:0.636-0.911). Those in the 18 years or older age group had 0.79 times (OR =0.79, CI: 0.635-0.974) lower odds of tobacco smoking quit attempt.

Notably, the bivariate analyses showed a positive association between tobacco quit attempt and school type, race, age at initiation of e-cigarette, and household exposure to tobacco smoking. The odds of tobacco quit attempt were 1.36 times (OR= 1.36, CI:1.13 -1.63) as likely among middle school students when compared to high school students. The unadjusted odds of tobacco quit attempt were higher among Hispanics (OR =1.35, CI:1.10-1.66) and Black/African Americans (OR=1.15, CI:0.90-1.46) but lower among other races (OR =0.98, CI: 0.78-1.22) as compared to Non-Hispanic Whites. Adolescents exposed to tobacco smoking in the home (OR=1.25, 95% CI:1.08 -1.45), those in middle school (OR = 1.36, 95% CI: 1.13 -1.63), those who had their first e-cigarette before age 13(OR=1.39, 95%CI:1.083-1.772) and females (OR=1.04, 95% CI: 0.895-1.206) were positively linked with higher odds of attempting to quit tobacco smoking. Both e-cigarette use and HTP use were associated with greater odds of attempting to quit tobacco smoking

(OR =1.18, CI:0.90-1.54 and OR= 1.07, 95% CI:0.823- 1.384 respectively). However, the associations were not statistically significant.

Table 2: Bivariate logistic regression examining the relationship between each study variable and tobacco quit attempt.

Variables	Odds Ratio	95% Confidence Interval	
		Lower limit	**Upper limit**
Age in years			
9-12	1.254	0.897	1.754
13-15	Reference		
16-17*	**0.761**	**0.636**	**0.911**
18 years or older*	**0.787**	**0.635**	**0.974**
Race/Ethnicity			
Non-Hispanic White	Reference		
Non-Hispanic Black	1.147	0.899	1.464
Hispanic*	**1.353**	**1.101**	**1.664**
Other	0.976	0.780	1.221
Gender			
Male	Reference		
Female	1.039	0.895	1.206
School Type			
High	Reference		
Middle *	**1.356**	**1.125**	**1.634**
Household Tobacco smoke exposure			
No	Reference		
Yes *	**1.251**	**1.076**	**1.454**
Age at initiation of e-cigarette			
9-12 *	**1.385**	**1.083**	**1.772**
13-15	1.094	0.899	1.330
16-17	Reference		
18 years and older	0.894	0.710	1.126
E-cigarette Use			
No	Reference		
Yes	1.184	0.909	1.542
E-Cigarette awareness			
No	Reference		
Yes	0.803	0.512	1.259
HTP Use			
No	Reference		
Yes	1.067	0.823	1.384
HTP Awareness			
No	Reference		
Yes	1.079	0.902	1.290

*p<0.05

Tobacco Quit Attempt

4.3 Multivariate logistic regression results for e-cigarette

Table 3 shows the frequency of tobacco quit attempt and the corresponding adjusted odds ratio (aOR) for all the study variables, except for HTP use and HTP awareness (assessed separately). The aORs were estimated using four different multivariate logistic regression models. **Model 1** shows the aORs for the sociodemographic variables age, race, gender, school type, household exposure to tobacco smoking, and age at initiation of e-cigarette. After adjusting for all covariates, there was no longer a significant association between school type and tobacco quit attempt (aOR= 1.08, 95% CI:0.811-1.439). The adjusted estimates show that age, race, and household exposure to tobacco smoking were significantly associated with attempting to quit tobacco smoking. Adolescents within the 16-17 age group were 0.75 (aOR=0.75, 95% CI: 0.578-0.972) less likely to attempt to quit tobacco smoking compared to those within the 12-15 age group. Conversely, Hispanic Whites were 1.38 times (aOR=1.38, 95% CI:1.110-1.711) as likely to attempt to quit tobacco smoking when compared with Non-Hispanic Whites after adjusting for age, gender, school type, household exposure to tobacco smoking, and age at initiation of e-cigarette. The odds of tobacco quit attempt were 1.19 times (aOR=1.19, 95% CI:1.1190-1.390) as likely among adolescents who are exposed to tobacco smoking in the home when compared to

those without household tobacco smoke exposure after adjusting for age, race, gender, school type, and age at initiation of e-cigarette.

All sociodemographic variables in **model 1** (age, race, gender, school type, household exposure to tobacco smoking, and age at initiation of e-cigarette) were adjusted for in subsequent models. In **model 2**, e-cigarette use was added to the model to examine its relationship to a tobacco quit attempt. The adjusted estimates also showed that age, race, and household tobacco exposure were associated with tobacco quit attempt. Hispanics were 1.39 times (aOR=1.388, 95% CI:1.118-1.722) as likely to attempt to quit tobacco smoking compared to non-Hispanic Whites, after adjusting for age, race, gender, school type, household exposure to tobacco smoking, and age at initiation of e-cigarette. Similarly, the odds of tobacco quit attempt were 1.19 (95% CI: 1.013- 1.390) times as likely among adolescents who are exposed to tobacco smoking in their home compared to those without household tobacco smoke exposure. After adjusting for age, race, gender, school type, household exposure to tobacco smoking, and age at initiation of e-cigarette, the odds of attempting to quit tobacco smoking was 2.61 times (aOR= 2.609, CI: 0.918-7.415) as likely among e-cigarette users compared to non-e-cigarette users. However, this association was not statistically significant. A trend was observed for age at initiation of e-cigarette; the older the age at first use of an e-cigarette, the lower the odds of making an attempt to quit tobacco smoking. This relationship was not statistically significant.

Model 3 shows the adjusted odds ratios when e-cigarette use was removed from the model and replaced with e-cigarette awareness. The adjusted estimates show that age, race, and exposure to tobacco smoking in the home are significantly associated with tobacco quit attempt. After adjusting for age, race, gender, school type, household

exposure to tobacco smoking, and age at initiation of e-cigarette, the likelihood of tobacco quit attempt was 1.40 times(95% CI:1.128-1.743) as likely among adolescents who are Hispanic Whites compared to non-Hispanic Whites. After adjusting for other covariates, the odds of tobacco quit attempt were 1.19 times(95% CI: 1.015-1.388) as likely among adolescents living in a household with tobacco smoke exposure. There was a statistically significant association between the age group 16-17 years and tobacco quit attempt (aOR = 0.742, 95% CI:0.573-0.961). Adolescents between 16 and 17 years old were less likely to quit tobacco smoking when compared to those who are 13-15 years. After adjusting for age, race, gender, school type, exposure to household tobacco smoking, and age at initiation of e-cigarette, there was no statistical significance between e-cigarette awareness (addictiveness) and tobacco quit attempt (aOR =1.240, 95% CI:0.738- 2.083). A similar pattern was observed for age at initiation of e-cigarette as seen in previous models (Please see Table 2 model 1 and model 2). Though not statistically significant, adolescents who initiated e-cigarette after age 12 were less likely to make an attempt to quit tobacco smoking (please see Table 2 model 3).

Model 4 shows the adjusted odds ratios for all the study variables when e-cigarette use and e-cigarette awareness were added. After adjusting for all other variables, the odds of attempting to quit tobacco smoking were 0.74 times (aOR=0.738, 95% CI:0.569- 0.958) as likely among adolescents between 16 and 17 years of age compared to those aged 13-15. Similarly, race and household tobacco smoke exposure were associated with tobacco quit attempt; this was observed across all the models. Compared to non-Hispanic whites, the odds of tobacco quit attempt were 1.41 times (95% CI:1.136- 1.753) as likely among Hispanics and 1.19 times (95% CI:1.012- 1.387) as likely among adolescents who are exposed to tobacco smoking in the home. Middle school students (aOR=1.07, 95% CI: 0.80, 1.43), females (aOR=1.07, 95% CI:0.910-1.258), and those who initiated e-cigarette

use between the ages of 9-12 years (aOR=1.01, 95% CI:0.729-1.390)   had higher odds ratio for attempting to quit tobacco smoking when compared to high school students, males and those who initiated e-cigarette use between the ages of 16-17 respectively. While the odds for attempting to quit smoking were 2.59 times (95% CI: 0.86- 7.87) as likely among e-cigarette users, it was not statistically significant; this lack of statistical significance was consistent in all the previous models. After adjusting for age, race, gender, school type, exposure to household tobacco smoking, e-cigarette use, and e-cigarette awareness, the results showed that adolescents who initiated e-cigarette use at a younger age had higher odds of attempting to quit smoking as compared to those who started at an older age. However, this association was not statistically significant.

Table 1:Prevalence of Tobacco quit attempt by socio-demographic characteristics, and multivariate association of the use and awareness of E-cigarette and smoking quit attempt.

Participant Characteristic	Tobacco quit attempt N (%)		Quit Attempt			
	Yes	No	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Age						
9-12	174 (3.890)	91 (2.019)	1.196 (0.834- 1.715)	1.190 (0.829-1.708)	1.226 (0.863-1.740)	1.211 (0.850-1.726).
13-15	977(23.939	645 (15.586)	Reference	Reference	Reference	Reference
16-17*	816 (21.158)	704 (18.097	**0.749(0.578-0.972)**	**0.746 (0.575- 0.969)**	**0.742 (0.573- 0.961**	**0.738 (0.569-0.958)**
18 years and older	302 (8.378)	261 (6.934)	0.842 (0.591-1.200)	0.839 (0.588-1.196)	0.823 (0.577- 1.176)	0.820(0.573-1.171)
Race/Ethnicity NH-White	1111 (31.496)	908 (25.366)	Reference	Reference	Reference	Reference
Back/AA	243(6.099)	170 (4.283)	1.170 (0.860-1.593)	1.171(0.860- 1.593)	1.156 (0.849- 1.574)	1.154 (0.848-1.572)
Hispanic *	672 (14.468)	431 (8.610)	**1.378 (1.110-1.711)**	**1.388 (1.118-1.722)**	**1.402 (1.128- 1.743)**	**1.411 (1.136-1.753)**
Other	245 (5.303)	193 (4.374)	0.978 (0.745-1.285)	0.992 (0.755-1.305)	0.980 (0.747- 1.287)	0.994 (0.756-1.308)
Gender Male	1239 (30.093)	921(22.826)	Reference	Reference	Reference	Reference
Female	1019 (26.984)	774(19.702)	1.078 (0.916-1.268)	1.078 (0.915- 1.269)	1.070 (0.911- 1.257)	1.070 (0.910- 1.258)
School Type High	1609 (42.354)	1318(33.894)	Reference	Reference	Reference	Reference
Middle	649 (14.937)	379 (8.816)	1.081 (0.811-1.439)	1.091 (0.818-1.455)	1.060 (0.796- 1.412)	1.070 (0.803- 1.427)

Participant Characteristic	Tobacco quit attempt N (%)		Quit Attempt			
	Yes	No	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Household Tobacco smoke exposure*						
No	1257 (32.452)	1049(26.662)	Reference	Reference	Reference	Reference
Yes	953 (24.676)	623(16.210)	1.081 (0.811-1.439)	**1.187 (1.013- 1.392)**	**1.187 (1.015-1.388)**	**1.185 (1.012- 1.387)**
Age at initiation Of e-cigarette						
9-12	457 (12.376)	269 (7.12)	1.038 (0.757-1.421)	1.032 (0.752- 1.415)	1.014 (0.735- 1.399)	1.008 (0.729- 1.393)
13-15	725 (19.560)	519(14.25)	0.900 (0.724-1.119)	0.899 (0.724- 1.118)	0.893 (0.714- 1.118)	0.893 (0.714-1.117)
16-17	673 (19.574)	554(15.59)	Reference	Reference	Reference	Reference
18 years or older	211 (6.096)	189 (5.431)	0.883 (0.651-1.197)	0.882 (0.650-1.197)	0.880 (0.648- 1.195	0.879 (0.647- 1.195)
E-cigarette Use						
No	1528 (38.419)	174 (4.215)	------	Reference	------	Reference
Yes	2067 (52.500)	204 (4.866)		2.609 (0.918-7.415)		2.594 (0.856-7.866)
E-cigarette awareness						
No	55 (1.4623)	39 (0.881)	------	------	Reference	Reference
Yes	2163 (55.775)	1058(41.881)			0.993 (0.918-7.223)	0.789(0.468-1.333)

Note: --- Variable not included in the model,   *p<0.05,   Middle school (grade 6-8),   High school (Grade 9-12), NH-White (Non- Hispanic white), Black/AA(Black or African American), other (Asian, Pacific Islander, Hawaiian native, American Indian).

4.4 Multivariate logistic regression results for HTPs

Table 4 shows the frequency of tobacco quit attempt and the corresponding adjusted odds ratio (aOR) for all the study variables, excluding e-cigarette use and awareness. Four different multivariate logistic regression models were created to examine the relationship between tobacco quit attempt and the use and awareness HTPs.

Model 1 shows the aORs for the sociodemographic variables age, race, gender, school type, and household exposure to tobacco smoking. After adjusting for all the other variables, there was no longer a significant association between students within the 9-12 age group (aOR=1.168, 95% CI:0.839-1.626) and tobacco quit attempt. Similarly, after adjusting for age, race, gender, and household tobacco smoke exposure, there was no longer a significant association between school type (aOR =1.068, 95% CI:0.823-1.387) and tobacco quit attempt. Hispanic Whites were 1.28 times (aOR=1.282, 95% CI: 1.035-1.589) as likely as their counterparts to make an attempt to quit tobacco smoking (non-Hispanic white) after adjusting for age, gender, school type, and household exposure to tobacco smoking. The odds of tobacco quit attempt was 1.21 times (aOR= 1.231, 95% CI:1.056-1.434) as likely among adolescents who are exposed to tobacco smoking in the home when compared to those without household tobacco smoke exposure, after adjusting for age, race, gender, school type, and age at initiation of e-cigarette.

Model 2, HTP use was added to the model to examine its relationship to tobacco quit attempt. The adjusted estimates show that adolescents aged 9-12 are 1.51 times (95% CI:1.010- 2.258) as likely to quit tobacco smoking when compared to those who are 13-15 years old. Conversely, adolescents aged 16-17 had 0.77 times (95% CI:0.591-0.993) the odds (aOR= 0.766, 95% 0.591-0.993) of tobacco quit attempt compared to those in the 13-15 age

group. After adjusting for all other variables in the model, the odds of tobacco quit attempt were 1.32 times (95% CI:1.045-1.664) as likely among Hispanic whites compared to non-Hispanic whites. Exposure to tobacco smoking in the home was another significant factor of tobacco quit attempt. Adolescents who live in a household where they are exposed to tobacco smoking were 1.23 times (aOR=1.226, 95% CI:1.032-1.456) as likely to attempt to quit tobacco smoking compared to those who are not exposed to tobacco smoking in the home.

In model 3, HTP use was replaced with HTP awareness. After adjusting for all covariates, the odds of tobacco quit attempt were 1.47 times (aOR =1.468, 95% CI:1.033-2.087) as likely among those between the ages of 9-12 compared to those who are 13- 15 years old. Notably, the odds of tobacco quit attempt decreased with increasing age when HTP awareness was added to the model. The aOR for adolescents between 16-17 years old was 0.830, 95% CI:0.643-1.072 and for those 18 years or older, aOR = 0.824 (95% CI:0.625-1.086). There was a statistically significant association between household tobacco smoke exposure and tobacco quit attempt. The odds of tobacco quit attempt were 1.20 times (95% CI: 1.003-1.436) as likely among adolescents living in a household with tobacco smoke exposure. There was no statistically significant association between HTP awareness (aOR=1.007, 95% CI: 0.818-1.239) and tobacco quit attempt.

Both HTP use and HTP awareness were included in the final model. After adjusting for age, race, gender, school type, and household tobacco exposure, the estimated odds ratio for making a quit attempt decreased with increasing age. After adjusting for other variables, the odds of tobacco quit attempt were 1.51 times (aOR= 1.514, 95% CI:1.008-2.273) as likely among adolescents aged 9-12 compared to those aged 13-15. Hispanics adolescents were

more likely to have made a quit attempt compared to non-Hispanic White adolescents (aOR=1.310, 95% CI:1.015-1.690) after adjusting for all other variables. Similarly, adolescents exposed to tobacco smoke in the home were 1.23 times (95% CI:1.027-1.468) as likely to attempt to quit tobacco smoking compared to their peers who are unexposed to tobacco smoking in the house. There was no statistically significant association between HTP use or HTP awareness, and tobacco quit attempt aOR= 0.91 (95% CI:0.599-1.377) and aOR=1.00 (95% CI: 0:717-1.397) respectively.

Table 2: **Prevalence of Tobacco quit attempt by socio-demographic characteristics and multivariate association of the use and awareness of HTPs and smoking quit attempt.**

Participant Characteristic	Tobacco quit attempt N (%)		Quit Attempt			
	Yes	No	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Age						
9-12*	174 (3.890)	91 (2.019)	1.168 (0.839-1.626)	**1.510 (1.010- 2.258)**	**1.468 (1.033-2.087)**	**1.514 (1.008-2.273)**
13-15	977(23.939)	645 (15.586)	Reference	Reference	Reference	Reference
16-17*	816 (21.158)	704 (18.097)	0.795 (0.632-1.000)	**0.766 (0.591-0.993)**	0.830 (0.643-1.072)	0.804 (0.614-1.052)
18 years and older	302 (8.378)	261 (6.934)	0.811 (0.627-1.048)	0.783 (0.596-1.028)	0.824 (0.625-1.086)	0.807 (0.604-1.078)
Race/Ethnicity						
NH-White	1111 (31.496)	908 (25.366)	Reference	Reference	Reference	Reference
Back/ AA	243(6.099)	170 (4.283)	1.099 (0.858-1.408)	1.190 (0.854-1.658)	1.252 (0.870-1.802)	1.242 (0.849-1.817)
Hispanic *	672 (14.468)	431 (8.610)	**1.282 (1.035-1.589)**	**1.319 (1.045-1.664)**	1.249 (0.966-1.614)	**1.310 (1.015-1.690)**
Other	245 (5.303)	193 (4.374)	0.962 (0.754-1.227)	0.891 (0.709-1.119)	0.952 (0.747-1.214)	0.882(0.696-1.117
Gender						
Male	1239 (30.093)	921(22.826)	Reference	Reference	Reference	Reference
Female	1019 (26.984)	774(19.702)	1.078 (0.916-1.268)	1.078 (0.915- 1.269)	1.070 (0.911- 1.257)	1.070 (0.910- 1.258)

| Participant Characteristic | Tobacco quit attempt N (%) | | Quit Attempt | | | |
| | | | Model 1 | Model 2 | Model 3 | Model 4 |
	Yes	No	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
School Type						
High	1609 (42.354)	1318(33.894)	Reference	Reference	Reference	Reference
Middle	649 (14.937)	379 (8.816)	1.068 (0.823-1.387)	1.064 (0.790-1.437)	1.083(0.795-1.473)	1.098 (0.784-1.538)
Household Tobacco smoke exposure						
No	1257 (32.452)	1049(26.662	Reference	Reference	Reference	Reference
Yes*	953 (24.676)	623(16.210)	**1.231 (1.056-1.434)**	**1.226 (1.032-1.456)**	**1.200 (1.003-1.436)**	**1.228 (1.027-1.468)**
HTP Use						
No	1694 (52.122)	128(39.033)	------	Reference	------	Reference
Yes	165 (5.198)	117(3.647)		0.948 (0.719-1.251)		0.908 (0.599-1.377)
HTP awareness						
No	1367 (45.693)	1058(34.774)	--------	--------	Reference	Reference
Yes	356 (11.455)	254 (8.078)			1.007(0.818-1.239)	1.001 (0.717-1.397)

Note: --- Variable not included in the model,   *p<0.05,   Middle school (grade 6-8),   High school (Grade 9-12), NH-White (Non- Hispanic white), Black/AA(Black or African American), other (Asian, Pacific Islander, Hawaiian native, American Indian).

Table 5 shows the crude and adjusted odds of tobacco quit attempt among users of both HTPs and e-cigarettes. As compared to non-HTP users, the odds of smoking quit attempt were 0.88 times (95% CI: 0.572-1.351) as likely among HTP users after adjusting for age, race, gender, school type, e-cigarette awareness (addictive property), and household exposure to tobacco smoking. However, this association was not statistically significant. Conversely, the odds of tobacco quit attempt were 1.17 times (95% CI: 0.869- 1.581) as likely among e-cigarette users compared to non-e-cigarette users after adjusting for all other covariates. This association was also not statistically significant.

Table 3: Crude and Adjusted OR for the relationship between the combined use of e-cigarettes and HTPs and tobacco quit attempt.

Characteristics	Unadjusted OR (95% CI)	Adjusted OR(95% CI)	*P*
HTP use ††			
Yes	1.067 (0.727- 1.351)	0.879 (0.572- 1.351)	0.55
No	Reference	Reference	
E-cigarette use††			
Yes	1.184 (0.909-1.542)	1.172 (0.869- 1.581)	0.29
No	Reference	Reference	

††Adjusted for age, race, gender, school type, e-cigarette awareness, and household exposure to tobacco smoking.

CHAPTER V: DISCUSSION AND CONCLUSION

5.1 Discussion of results

The marketing claims of tobacco companies regarding the benefit of alternative tobacco products such as smoking cessation aid remain controversial. A literature review shows a lack of consistency about the positive association between tobacco smoking quit attempts and the use of alternative tobacco products. A previous study by Kalkhoran & Glantz (2016) found that the odds of discontinuing tobacco smoking was 28% lower among e-cigarette users compared to non-e-cigarette users. Similarly, the results of a comparative study by Chapman & Wu (2014) showed that e-cigarette use was not consistently associated with a tobacco quit attempt. Studies in support of the lack of association between e-cigarette use and tobacco quit attempt include studies done in Finland (Kinnunen et al., 2015), Canada (Malas et al., 2016), and the U.S. (Sutfin et al., 2013). However, Kinouani et al. (2017) reported that smoking quit attempts were informed more by e-cigarette users than any other smoking group. Also, results from a six-month follow-up study revealed that e-cigarette users had a higher likelihood of attempting to quit smoking at least seven times than non-e-cigarette users. (Pasquereau et al., 2017).

There is currently an ongoing debate about the viability of these products to render tobacco marketing claims' benefits (Nyman et al., 2018). Given the inconsistencies in findings from literature and lack of substantial evidence from tobacco companies supporting their claim, this study was conducted using more robust nationally representative data. Using data from a nationally representative sample of middle and high school students in the U.S., we

sought to shed more light on alternative tobacco use by examining the relationship between self-reported awareness and use of e-cigarettes and HTPs. Also, to assess the prevalence of tobacco quit attempts among adolescents in the U.S.

The main strength of this report is that data is from the National Youth Tobacco Survey, hence representative in scope. The questionnaires and measurements in the National Youth Tobacco Survey were done using excellent techniques. The training and quality control measures of the National Youth Tobacco Survey give added reliability to the data and the results of this study.

Findings of this study showed an overall higher prevalence of tobacco quit attempt among adolescents between 13-15 years old (23.9%), non-Hispanic whites (31.5%), males (30.1%), high school students (42.4%), and among e-cigarette users (52.5%). Notably, a higher proportion of E-cigarette users attempted to quit smoking than their non-e-cigarette using counterparts (52.5% vs. 38.4%). This finding is consistent with results from a study conducted in Korea by Kang & Cho (2019), which investigated the prevalence and association of HTP use.

One crucial step toward tobacco cessation is attempting to quit. It was hypothesized that the use and awareness of e-cigarettes and HTPs were strongly associated with a tobacco quit attempt. However, despite numerous advertising and media messages claiming e-cigarettes to be a safer alternative to c-cigarettes and as a smoking cessation aid, findings from this study showed no statistically significant association between e-cigarette use and tobacco quit attempt after adjusting for age, race, gender, school type, age at initiation of e-cigarette and e-cigarette awareness. This finding was consistent with studies done in Finland

(Kinnunen et al., 2015), Canada (Malas et al., 2016), and the U.S. (Sutfin et al., 2013; Chapman & Wu, 2014; Kalkhoran & Glantz, 2016), which found no association of e-cigarette use and tobacco smoking cessation among adolescents and adults. Similarly, analyses stratified by gender (result not shown) showed no association between e-cigarette use and tobacco quit attempt (aOR= 1.01, 95% CI: 0.70-1.463, P= 0.9518). After adjusting for all other variables, there was no statistical significance between the self-reported awareness of the addictiveness of e-cigarette and tobacco quit attempt within the past year. This finding was also consistent with a 2014 study conducted in the U.S., which reported no significant association between e-cigarette awareness and past-year quit attempts (Tan & Bigman, 2014). However, this study's findings conflicted with the results of a longitudinal study that revealed that e-cigarette use for cessation was associated with increased odds of smoking cessation at 6 and 12 months follow-up compared to non-users of e-cigarette (Mantey et al., 2017).

A possible explanation for that finding may stem from the influence of the social and physical environment on one's health decisions and behaviors. The majority of participants in this study noted that the two main reasons for their use of e-cigarettes were: 1. because they are being used by a friend or family member and 2. they were curious about them. It is, therefore, possible that adolescents may have begun using these products because they are trendy, popular, publicly available (Malas et al., 2016), or as a consequence of the influence of peers, family members, and advertisements (a risk factor for use) and not to aid in tobacco quit attempt (Gentzke et al., 2019). Also, the ability to experiment with the nicotine content in electronic cigarettes may increase the likelihood of addiction, leading to increased use but no benefit of smoking cessation. Sutfin et al. (2013) found that 12% of e-cigarette users had

never smoked a conventional cigarette or any other tobacco product. Sutfin et al.'s 2013 study may indicate that adolescents use e-cigarettes as a substitute for traditional tobacco (combustible cigarette) rather than smoking cessation aid. Another possible explanation for the lack of association may be a consequence of the cross-sectional study design. There may not have been an adequate amount of time in-between adolescents becoming aware of the addictive properties of e-cigarettes and their decision to quit tobacco smoking (Chapman & Wu, 2014). Although this study did not examine poly-tobacco use, research shows that it is more difficult for tobacco smokers to quit smoking when using alternative tobacco products and multiple conventional tobacco products concurrently (Popova & Ling, 2013). The possibility exists that e-cigarette users in this study were also using various tobacco products, making it more difficult for them to quit. Also, how e-cigarette use (one of the independent variables) was defined differs between studies. In this study, e-cigarette use was defined as using an e-cigarette on at least one day in the entire lifetime. In contrast, e-cigarette use was defined by Pasquereau et al (2017) as regular use of e-cigarette within the past 30 days.

This study showed no significant association between the use and awareness of HTPs and tobacco quit attempts. This finding was consistent with a longitudinal CHOICE-STRATA cohort study done in the U.S. among 6th and 7th-grade students, which demonstrated no correlation between HTP use and awareness and tobacco quit attempts. This finding supports the results of a study done in Korea (Kang & Cho, 2019), which showed no association between HTP use and awareness and tobacco quit attempts (Kang & Cho, 2019). According to the CDC, the period of adolescence and young adulthood represents the transition to adulthood, which is accompanied by risk-taking in an attempt to acquire adult

behavior (Health, 2012). Though awareness is necessary, it may not be adequate for adopting changes in one's health decisions and behaviors (Tan & Bigman, 2014).

In this study, the prevalence of tobacco quit attempts among adolescents in the U.S. was also assessed based on sociodemographic characteristics. This study suggests that age, race, and household exposure to tobacco smoking were significantly associated with a tobacco quit attempt. Research shows that there are disparities among racial/ethnic groups in relation to smoking behaviors, such as quit attempts (Choi et al., 2018; Kahende et al., 2011). This study showed that there were notable differences in tobacco quit attempts among different racial/ethnic groups. There was a statistically significant association between Hispanic Whites and tobacco quit attempts in the final models when both e-cigarette use and awareness & HTP use and awareness were examined (OR=1.41, 95% CI:1.14- 1.75 and OR=1.31, 95% CI:1.02-1.36 respectively). This finding was consistent with a 2011 study that examined quit attempt correlates by race/ethnic group, which found that Hispanics were more likely to have made tobacco quit attempts than whites (Kahende et al., 2011). Results from a 2018 study that looked at the trend (over 29 years) in smoking and smoking cessation among women showed that Hispanics are more likely to quit tobacco smoking (aOR= 1.09, 95% CI:1.02–1.16) compared to Blacks (aOR= 1.03, 95% CI:0.95–1.12) or Whites (aOR=1.01, 95% CI:0.97–1.06) (Li et al., 2018). This finding may be explained by the differences in cultural norms and the determinants of tobacco use. Historically, tobacco was used to suppress one's appetite, and as such, smoking cessation was linked to weight gain. Among females, Black women expressed less dissatisfaction with their body and are less influenced by media-driven messages relating to body image than white women (Chithambo & Huey, 2013).

Conversely, white women are more susceptible to tobacco use and less likely to quit due to cultural beliefs about the effects of weight gain post-cessation (Li et al., 2018). Another possible explanation for this disparity may be a result of biological differences in nicotine addiction. Research shows that adolescents who are users of multiple tobacco products have increased exposure to nicotine and are more likely to develop nicotine dependence than single product users (Choi et al., 2018). Hispanics may be single-product users and metabolize nicotine more slowly, and as such, they are less addicted and more likely to make quit attempts.

A positive association between tobacco quit attempt and household exposure to tobacco smoking was observed in all multivariate models. This finding supports a similar result from several studies conducted in 14 countries (Okoli & Kodet, 2015). Those studies demonstrated that exposure to smoking in the home was positively associated with attempting smoking cessation. One explanation for this result could be rooted in the ecological model of health behavior. Social and environmental interactions can influence smoking behaviors among adolescents (Health, 2012). Being in an environment where one is exposed to tobacco smoking may be a deterrent to smoking. Abrantes et al. (2009) reported that a generalized belief of tobacco's adverse health-related sequelae is related to attempting to quit. Adolescents in this study who are exposed to tobacco smoking at home may have observed, firsthand, the negative implications that smoking has on one's health. They may have had to become caregivers to family members who have become disabled due to tobacco smoking, or they may have lost a family member from illnesses associated with tobacco use. Another reason adolescents who are exposed to tobacco smoking in the home, more likely to quit smoking can be explained economically. They may have experienced the

negative economic effects/burden that tobacco has on the household. Parents or family members may choose to purchase tobacco products to satisfy their cravings rather than the necessary items needed to sustain their home, such as food, school supplies, medicine, or paying bills. Smoking material fires have resulted in deaths, injuries, and millions of dollars in property damage. (Shults, n.d.). According to the National Fire Prevention Association, cigarettes are the leading cause of house fires in the U.S. Smoking materials such as cigarettes or ashes dumped in garbage carelessly have resulted in the death of 700-900 people per year (*Cigarettes Are the Leading Cause of Home Fire Fatalities*, Aug. 2019). Adolescents may have experienced the misfortune of a house fire or loss of valuable items due to fire caused by tobacco smoking. For these reasons, they may be more likely to attempt to quit smoking than their peers who are unexposed to tobacco home at home.

This study's findings showed an overall lower odds ratio for tobacco quit attempts for older adolescents compared to younger adolescents. This finding was consistent with results from a 2009 survey by Abrantes et al., which showed lower odds of quitting among older individuals. One explanation for this finding is that younger smokers are probably less nicotine dependent and, as such, are more likely to attempt to quit smoking than older adolescents. This may suggest that if effective public health interventions to reach adolescent smokers are not implemented in time, the U.S. adolescent population may later suffer from severe diseases associated with tobacco use.

This study also demonstrated that e-cigarettes (34.7%) are more prevalent among middle and High school students than heated tobacco products (2.6%). This is similar to findings of studies conducted in Japan (Tabuchi et al., 2016), Korea (Kang & Cho, 2019), and

the U.S. (Nyman et al., 2018). It was observed that HTP use in Japan increased ten folds within two years of introduction to the Japanese market (Tabuchi et al., 2016). In Korea, the use is projected to surpass e-cigarette, which increased 20 folds within three years post-introduction (Kang & Cho, 2019). Therefore, it is essential to add that though HTP prevalence among adolescents is presently lower than e-cigarette in the U.S., there needs to be monitoring and surveillance of this product, particularly within the adolescent population, to identify use pattern and to implement fast, proactive control measures to prevent epidemic rates. While there was no statistical significance between the use and awareness of HTP or the use and awareness of e-cigarette and smoking quit attempt, there may exist a biological/clinically significant association.

5.2 Strengths and Limitations

There are some strengths and weaknesses of this study that may have implications in interpreting the results. The strengths of this study are 1. Survey data from a nationally representative sample was used, which allows the findings to be generalizable to adolescents in the U.S. 2. It provides an understanding of the prevalence of tobacco quit attempts by sociodemographic characteristics among middle and high school students in the U.S. There are some limitations of this study that need to be noted. The data was cross-sectional, allowing no causal conclusions since it is not known whether the factors that were examined preceded the outcome. In this study, respondents provided information that might be subject to reporting bias; thus, the true prevalence of tobacco quit attempt may be under-reported. Future studies using a prospective study design may provide more useful information about quit attempt. They should explore the differences in successful quit attempts among different

sociodemographic groups within the U.S. adolescent population. This study also did not consider the possibility of concurrent use of other cessation aids such as nicotine patches, sprays, etc. Future studies to compare the prevalence of quit attempt between individuals who are solely using alternative tobacco products as cessation aids and individuals who are using a combination therapy should be conducted to provide further insight into the factors that are associated with a quit attempt.

5.3 Public Health Practice and Policy Implications

The results of this study highlight the importance of comprehensive, efficacious public health interventions. A strong focus should be placed on tailoring interventions to the adolescent population. This should include health education and promotion geared towards increasing awareness of the deleterious effects of alternative tobacco product use. Tobacco health information must be communicated in plain language and should consider the health literacy level of the target population; this allows the message to be easily understood and interpreted. School-based interventions may play a critical role in reducing the appeal and acceptability of alternative tobacco products. One recommendation for intervention is to incorporate tobacco and substance use education into the school curriculum. This will provide an avenue through which adolescents will become more knowledgeable about the implications of tobacco use, thereby allowing them to make more informed decisions about the use of tobacco products.

Additionally, providing free tobacco cessation counseling at school and incentivizing students to participate in interscholastic competitions to deter tobacco product use and promote tobacco quit attempts may prove effective at mitigating the risks associated with

tobacco use. At the national level, implementing strategies to reduce the availability and marketing of alternative tobacco products should be considered. One approach that can be taken to reduce the prevalence and use among adolescents is to increase the taxes and sales price of these products, making them less affordable for adolescents. Healthcare providers may implement tobacco screening for adolescents in the clinical setting to assess tobacco use behaviors and provide necessary resources for them to successfully achieve smoking cessation (Marshall et al., 2016). Given that the result of this study revealed that race/ethnicity was associated with tobacco quit attempt, it is imperative to implement racial-ethnic specific culturally tailored interventions to increase self-efficacy and belief about the health-related consequences of tobacco use. Such an intervention may lead to higher rates of quitting.

5.4 Study Summary

The results of this study add to the growing body of E-cigarette, HTP, and youth tobacco cessation literature by providing additional data on the prevalence and factors that are associated with tobacco quit attempt among adolescents in the U.S. Provided that race, age, and household tobacco smoke exposure were significantly associated with smoking quit attempt, it imperative to identify subpopulations of adolescents that are less likely to attempt to quit and to tailor interventions to increase the likelihood and success rate of quit attempt. School-based interventions, national youth anti-tobacco campaigns, tailored tobacco health education to raise awareness and belief about the health consequences of smoking can have a positive impact on reducing the adolescent tobacco burden and should be considered when framing interventions

5.5 Conclusion

The results of this study showed no association between the awareness and use of e-cigarettes and Heated Tobacco Products and attempts to quit. However, race, age, and exposure to household tobacco were found to be positively associated with quit attempt. The lack of association between the use and awareness of e-cigarette and HTPs warrants the need for a more robust prospective study to determine the true nature of the relationship between use and awareness of alternative tobacco products and quit attempt.

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Appendix I
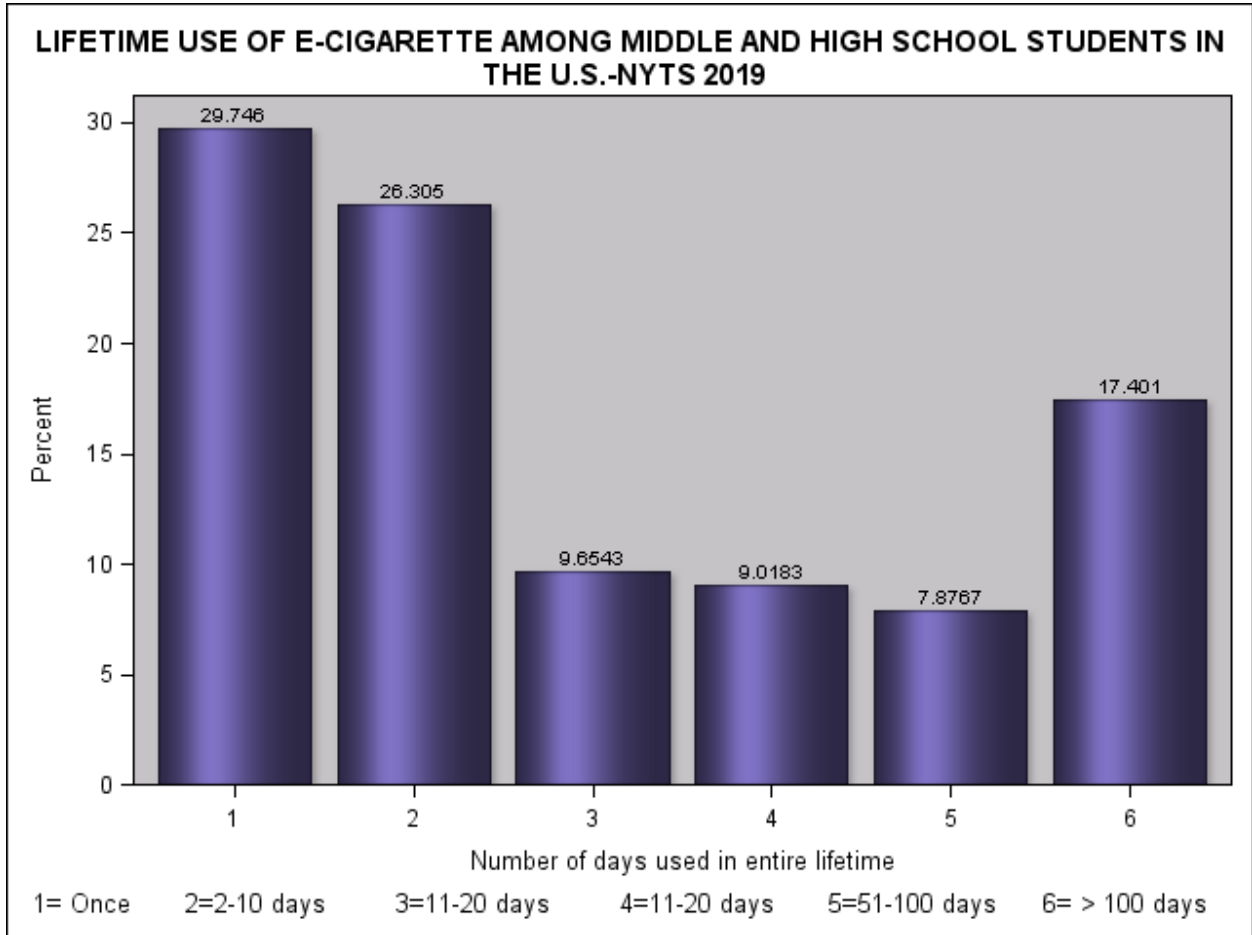
Figure 1: Bar chart showing the number of days middle and high school students used an e-cigarette in their lifetime
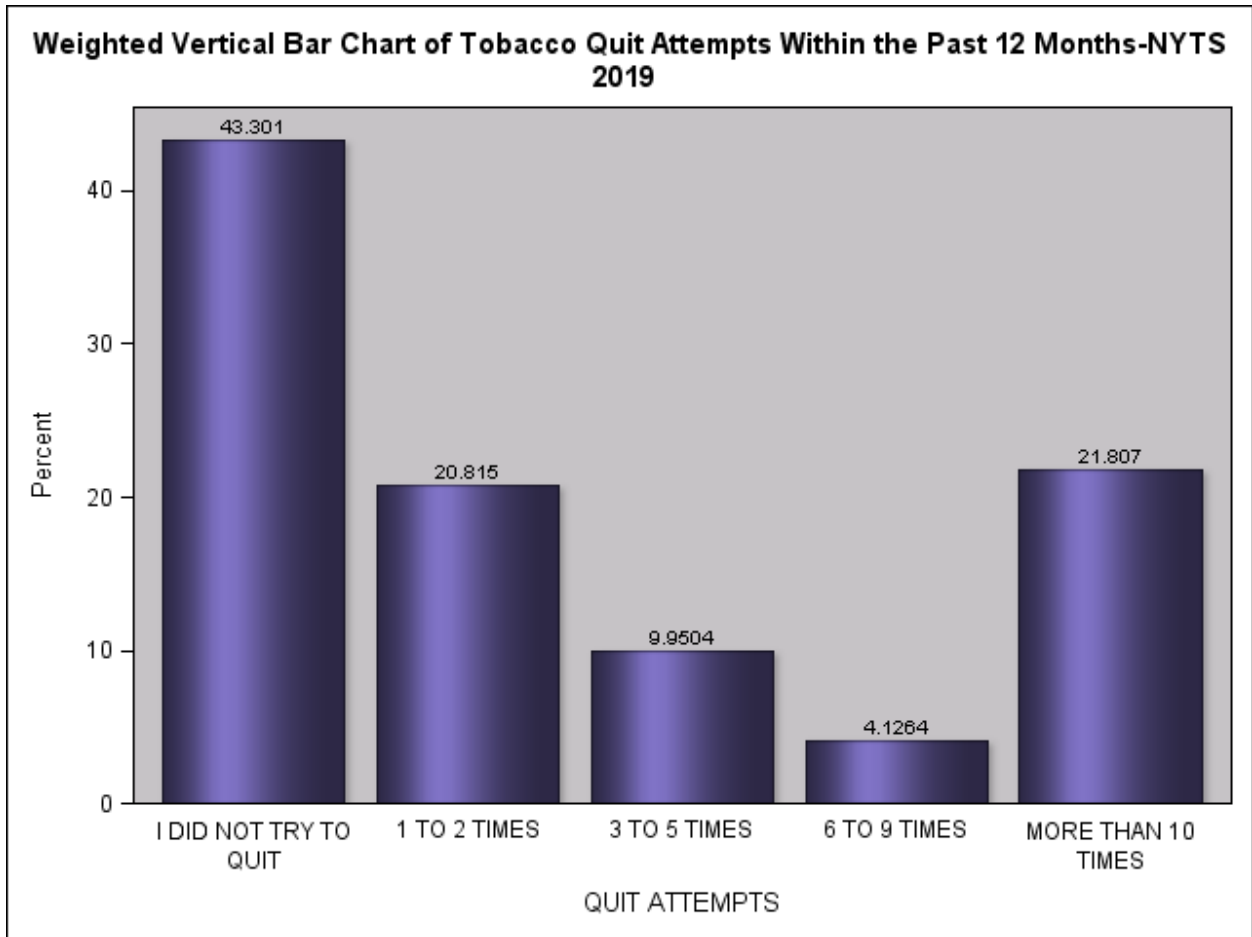
Figure 2: Bar chart showing the number of times middle and high school students made an attempt to quit tobacco smoking within the past 12 months.
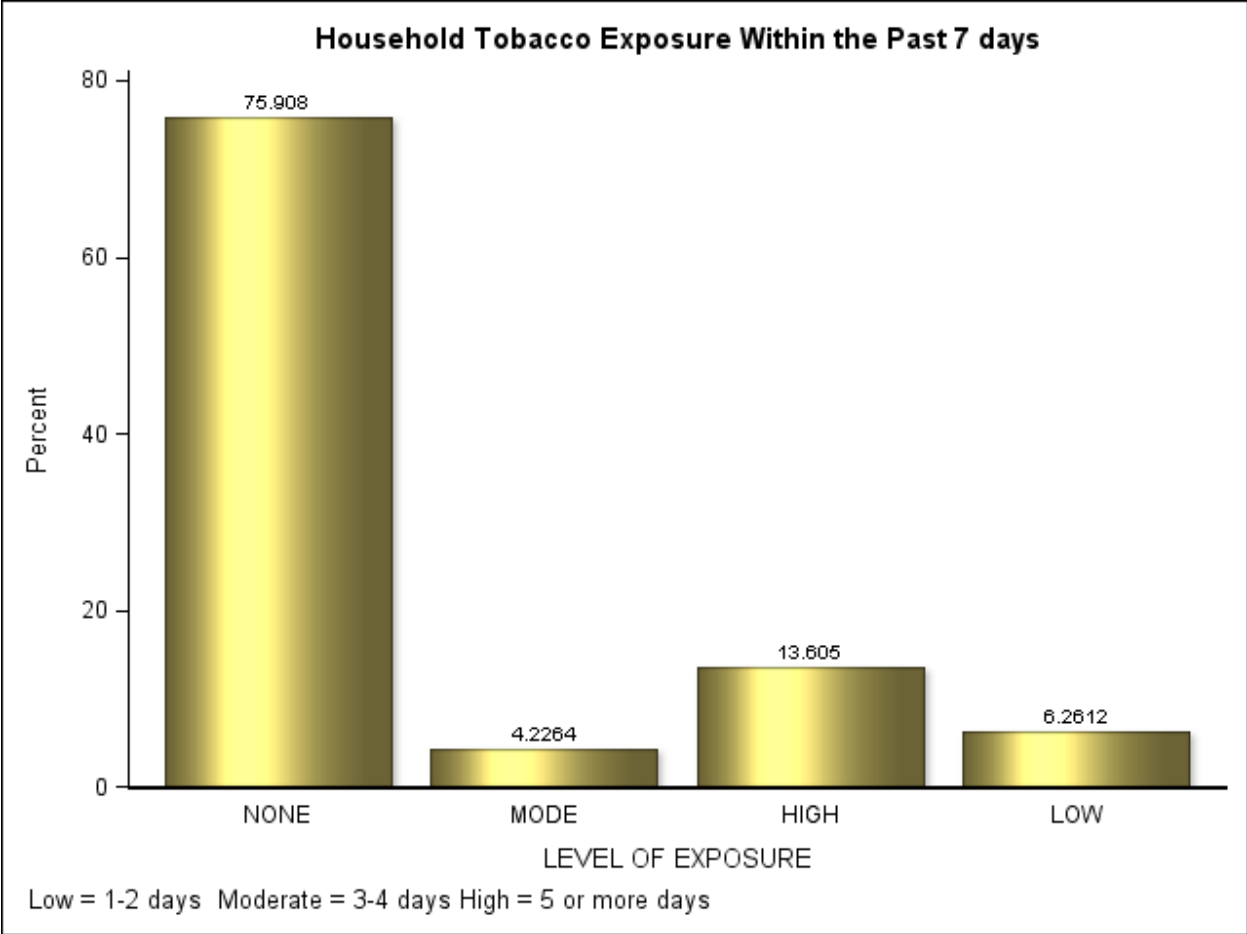
Figure 3: Bar chart displaying the level of exposure to tobacco smoking in the home reported by middle and high school students in the U.S.
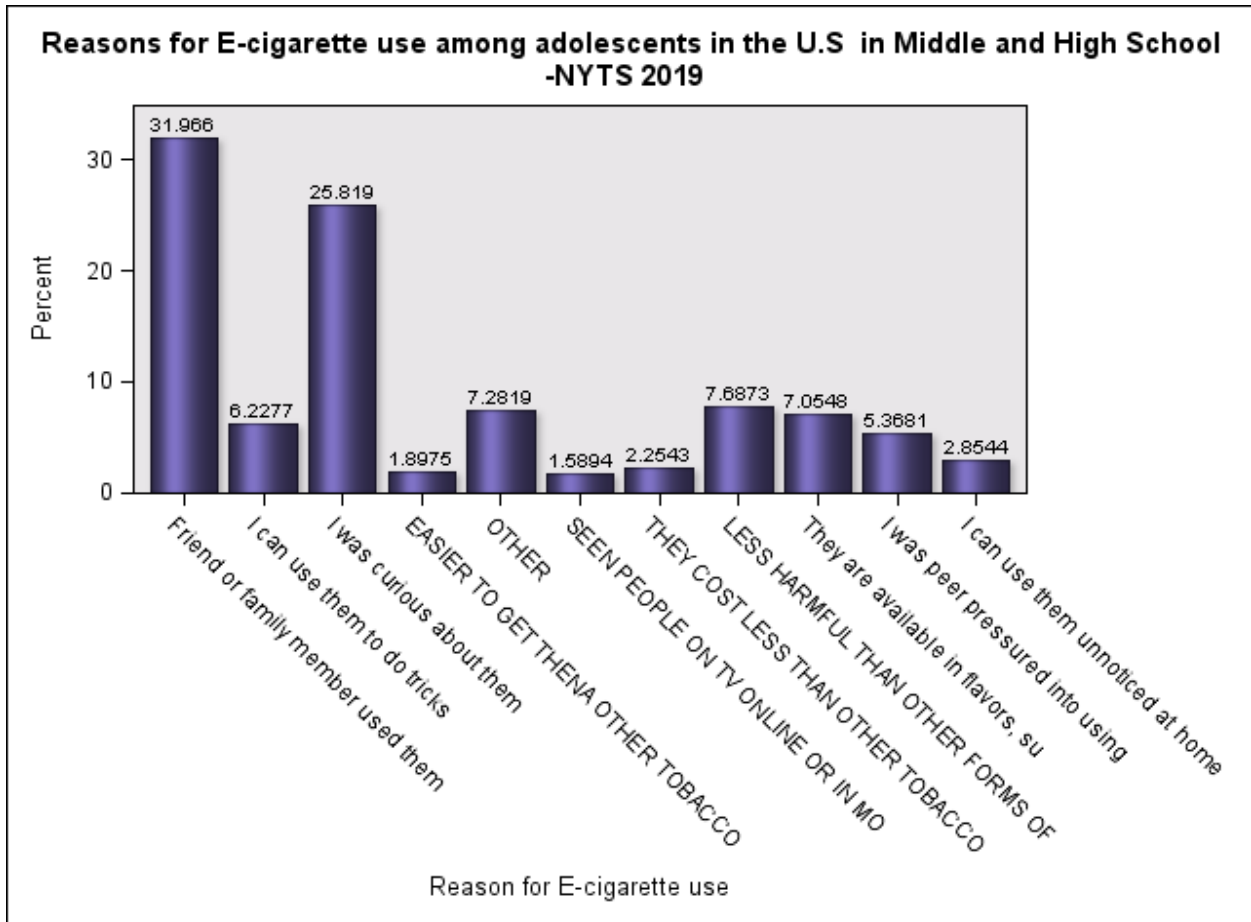
Figure 4: Bar chart showing the reasons for e-cigarette use reported by adolescents in the U.S.

Table 4: Summary of variables used in study

Variable names	Information	Scale and Analytical Codes
Main independent variables: E-cigarette use (Table 3: Model 1) and E-Cigarette awareness (Table 3:Model 2). HTP use (Table 4 Model 2) HTP awareness (Table 4 model 3)	The main independent variables, as shown in table 2 and table 3, were defined as having tried an e-cigarette on at least one day in the entire lifetime and Having tried HTP even once or twice.	Dichotomous: Yes/No Dichotomous: Yes/No
Self-reported Awareness of e-cigarettes and HTPs	These variables were defined respectively as being aware of the addictive property of e-cigarettes and having heard of HTP before.	Dichotomous: Yes/No
Covariates		
Age (years)	Current age at the time questionnaire was completed.	Categorical, four categories
Race and ethnicity	Assessed separately	Categorical, four categories
Gender/sex	Male or female	Categorial
Age at initiation	Data only available for e-cigarette	Categorical, four categories
School type	Respondents were categorized based on the type of school attended	Categorical, two categories (Middle or High)

Appendix III

Prevalence of tobacco quit attempt by socio-demographic factors

Distribution of quit attempt
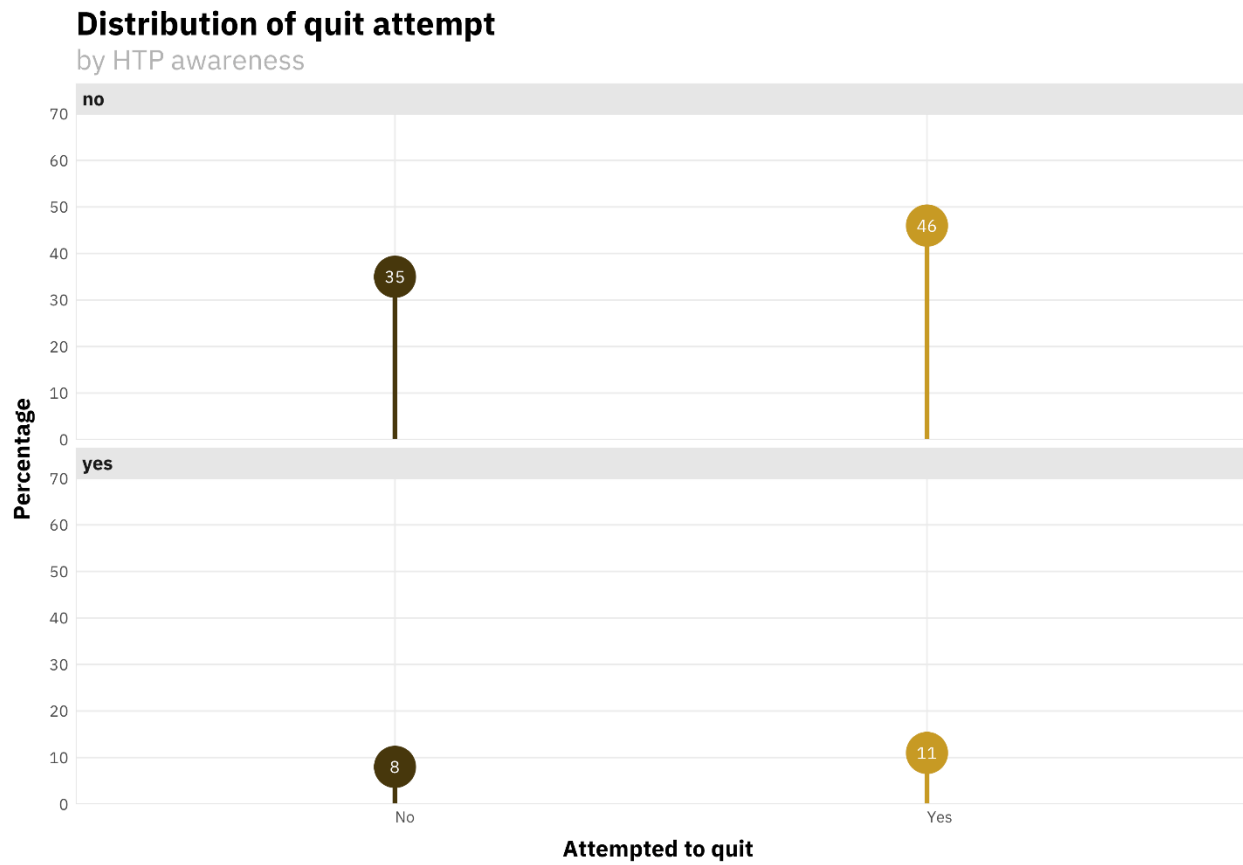by HTP awareness

Figure 5:Distribution of tobacco quit attempt by HTP awareness.

Distribution of quit attempt
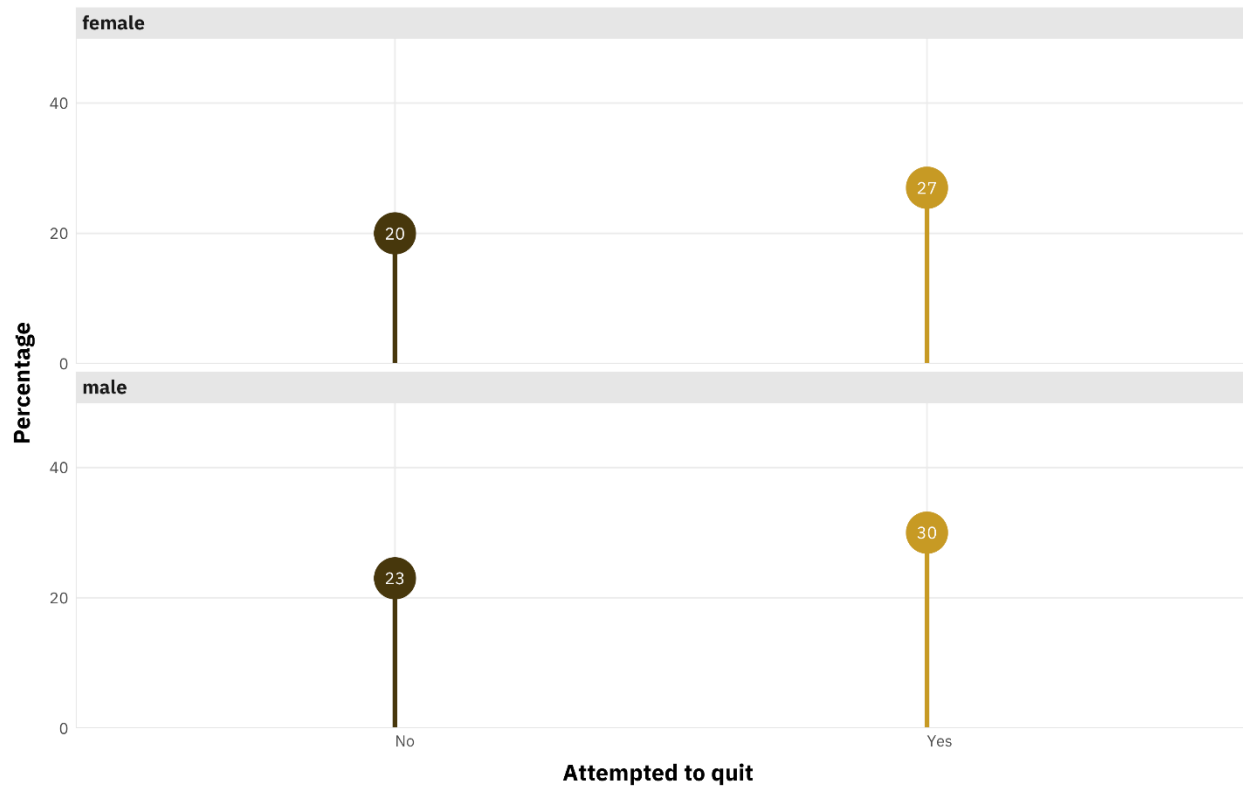by respondent's gender

Figure 6:Distribution of tobacco quit attempt by gender.

Distribution of quit attempt
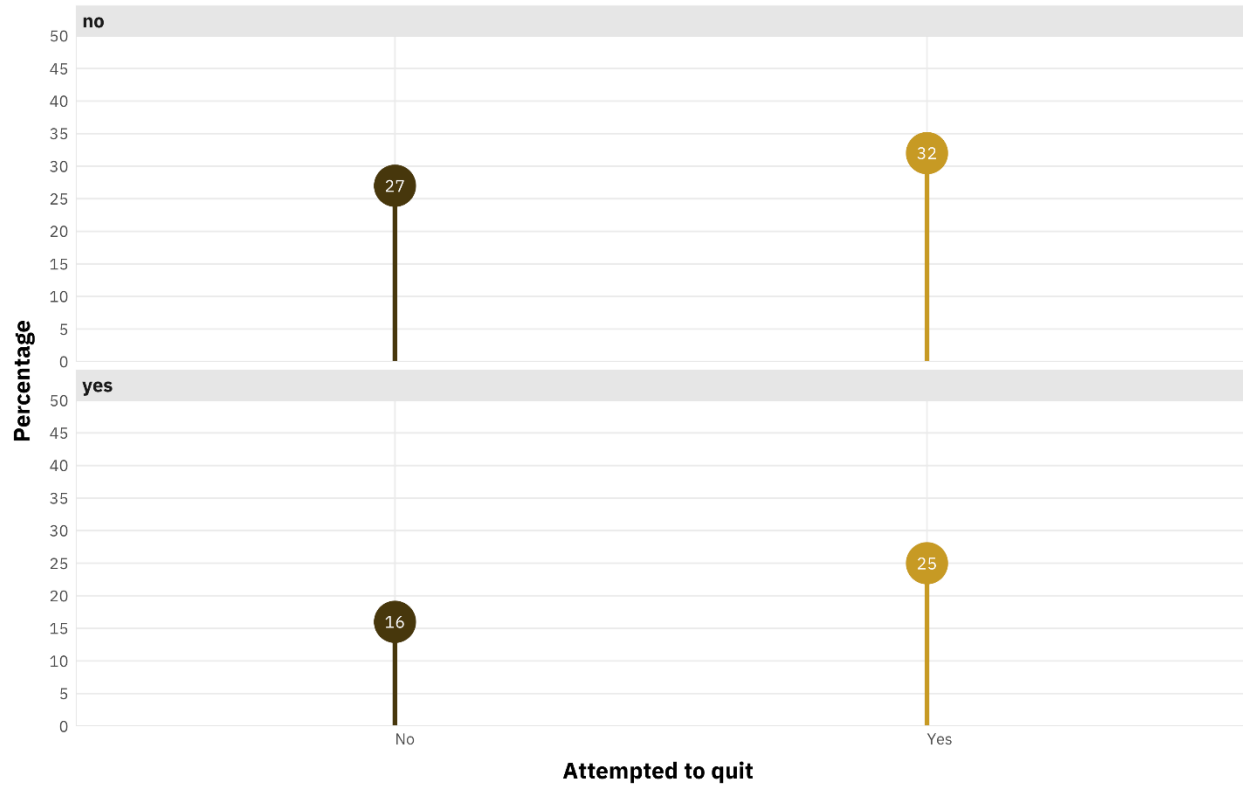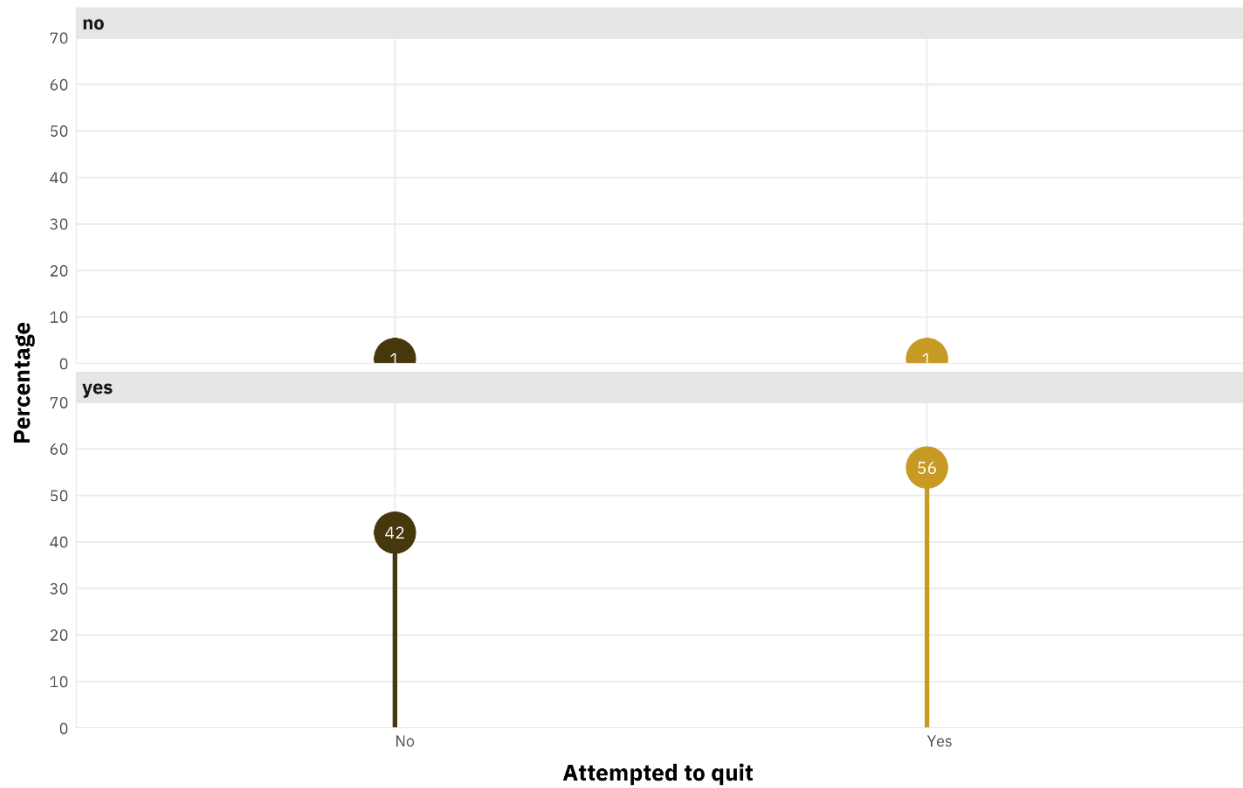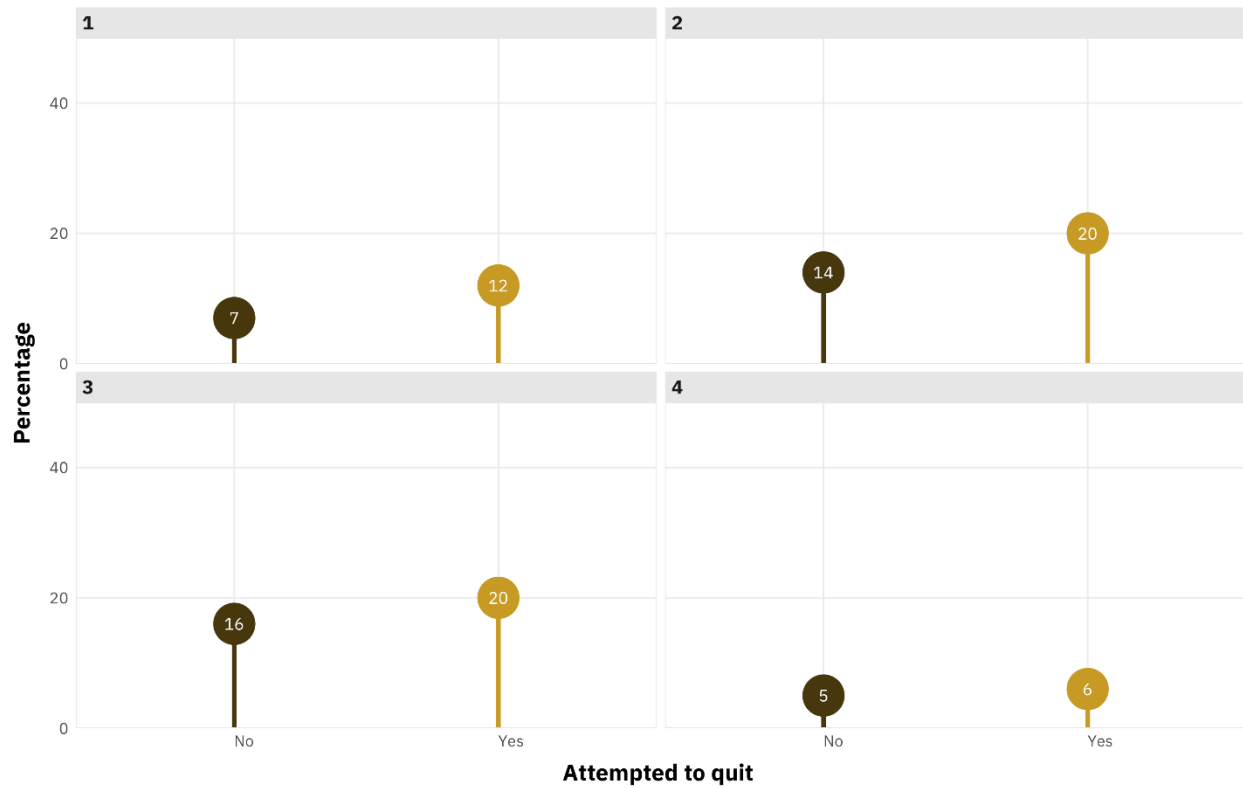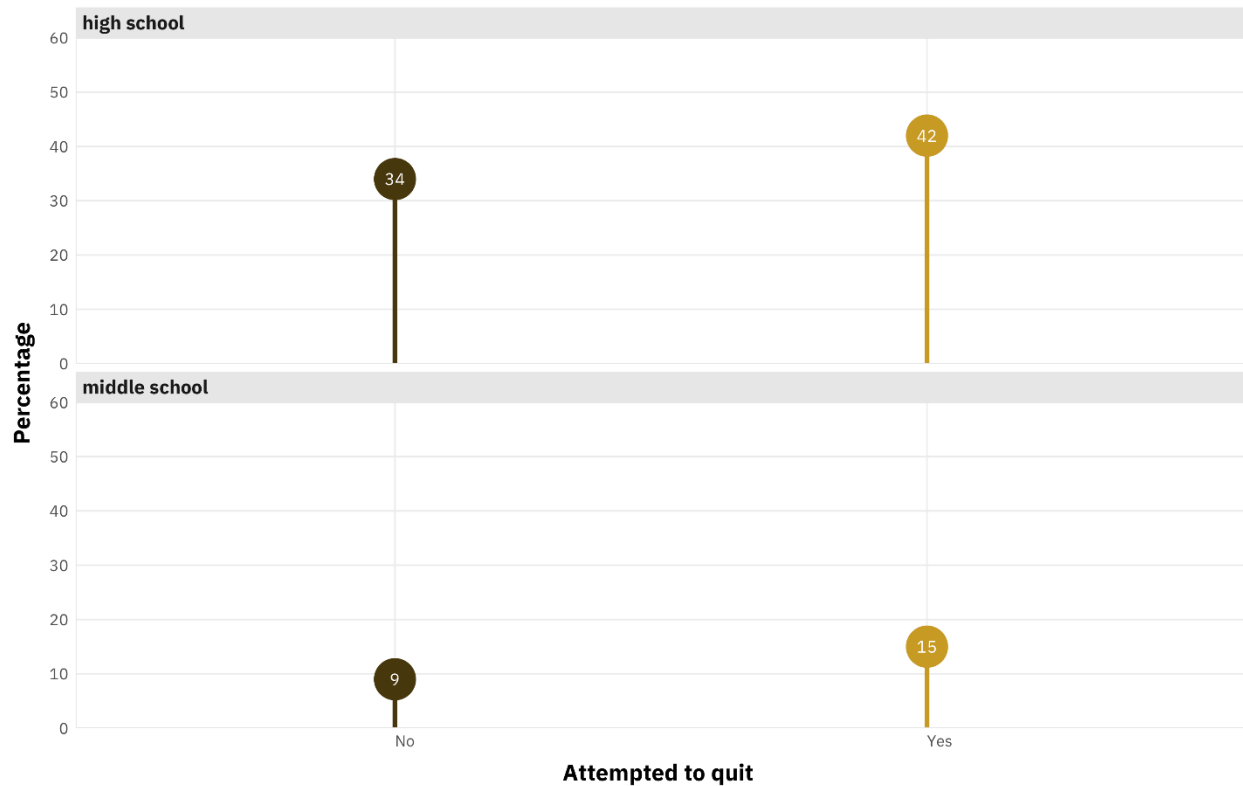by respondent's household exposure

Figure 7:Distribution of tobacco quit attempt by exposure to household tobacco smoking.

Distribution of quit attempt
by e-cigarette awareness

no

yes

Percentage

Attempted to quit

Figure 8: Distribution of tobacco quit attempt by e-cigarette awareness.

Figure 9: Distribution of tobacco quit attempt by age at initiation of e-cigarette

Figure 10: Distribution of tobacco quit attempt by age.

Figure 11: Distribution of tobacco quit attempt by school type.
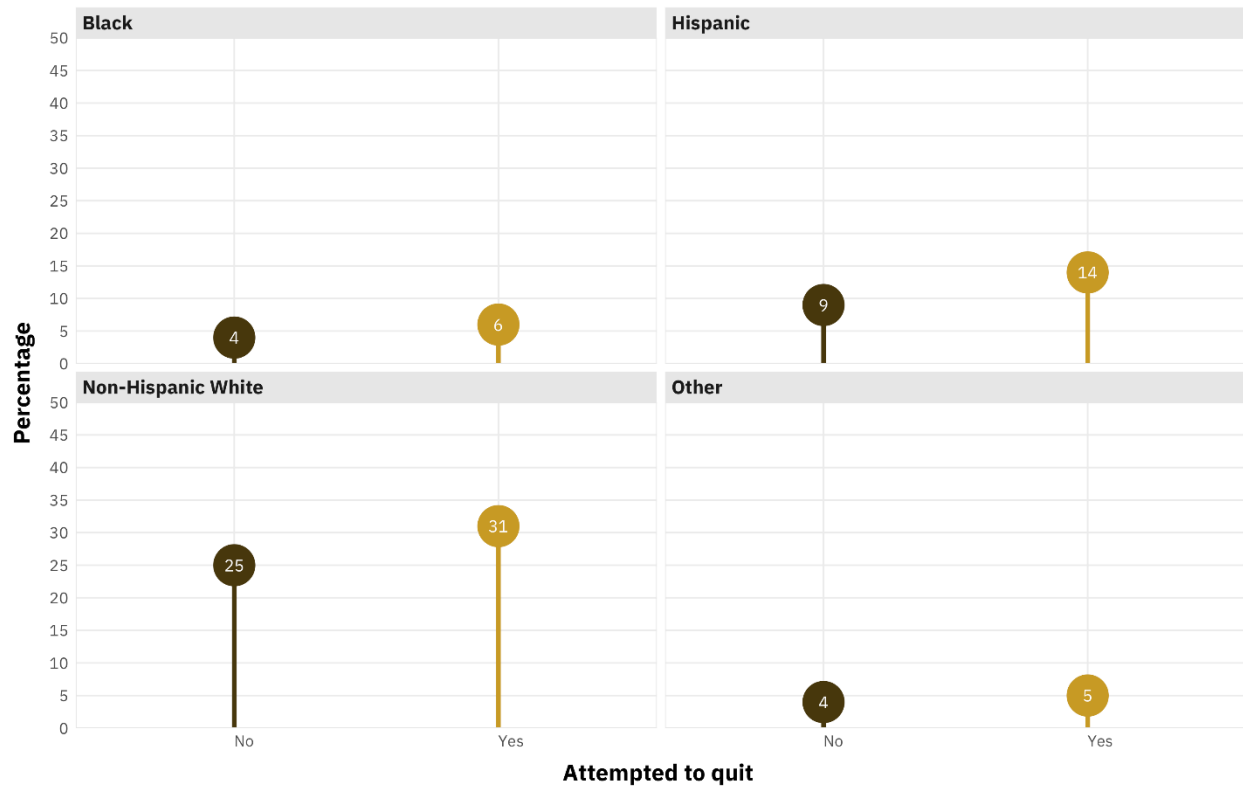
Distribution of quit attempt
by respondent's race

Figure 12: Distribution of tobacco quit attempt by race.