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Factors Associated with Electronic Cigarette Use Among Adolescents in Texas

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The use of electronic cigarettes among adolescents has remained a major public health concern. Reports have shown that the adolescent brain is still growing and can be affected by nicotine and cancer-causing chemicals contained in e-cigarettes. The rising trend of e-cigarette use by adolescents has reportedly reached an epidemic, and there is a knowledge gap in the factors associated with this behavior and the provision of appropriate interventions for the at-risk population. The purpose of this quantitative, cross-sectional study was to investigate the association between sociodemographic factors and the tendency of Texas adolescents to use e-cigarettes. This study was a secondary data analysis of the Texas Youth Tobacco Survey, involving Texas public school adolescents in grades 6-12. The sociodemographic risk factors used to investigate factors associated with e-cigarettes use (ECU) among Texas adolescents included age, gender, grade level, ethnicity, and race. The theory of planned behavior guided this study, and it posits that intentions are indications of how willing people are to perform certain behaviors. Statistical Package for Social Sciences version 25 was used to perform inferential statistics. Pearson's Chi-Square and Logistic Regression analyses were conducted to answer the research questions. The results showed that age ($p < .001$) and grade level ($p < .01$) were the most significant predictors of adolescent ECU. The findings from this study may have positive social change impact by providing better understanding of factors associated with adolescent ECU to help guide public health practitioners in developing audience-targeted health promotion programs for mitigating adolescent ECU.

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Dedication

This Dissertation is dedicated to the Only One and Invisible God Almighty, who has been my Strength, with whom all things are possible, and He had made this possible. I also dedicate this study to my beloved Children - Daniella Makuochukwu and Daniel Somtochukwu, who are my joy; to my Late Mum, whose memory is forever green; and to my Dad, for always encouraging and inspiring me to achieve greater heights.

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I would like to give glory and honor to God Almighty, for His grace which has been abundantly sufficient for me as I undertook this second doctoral journey following a career change and coming to completion about twenty-two years after my first doctorate.

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I also want to express my gratitude to my husband Godwin Diogu for his support, and to various family members, friends, and well-wishers who have contributed to my academic success through their support, encouragement, and motivation. They are too many to name here but I will not fail to mention my sister Dr. (Mrs.) Jayne Onwumere and my brother-in-law Dr. Augustine Onwumere, whose home have been my Children's other home over the past several years. I would also like to acknowledge the support from Maria Cooper and Nick Garza of the Texas Department of State Health Services who provided the data for my study. To all the Walden University Public Health Faculty who prepared me for this final process, the Research Staff who provided support for me in this dissertation, and all individuals who had in one way or the other provided me support and encouragement throughout this interesting dissertation journey, I say "thank you all."

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Introduction

Electronic cigarette use (ECU) among adolescents is a global public health challenge (Fairchild, Bayer, & Lee, 2019; Rohde et al., 2018). In the United States, it is an emerging public health concern (Sood, Kesic, & Hernandez, 2018; U.S. Department of Health and Human Services, 2016). Electronic nicotine delivery systems (ENDS), commonly referred to as electronic cigarettes (e-cigarettes), were patented in the United States in 2007 (Prochnow, 2017). Its use has been increasing among the youth, replacing the use of conventional cigarettes (Centers for Disease Control and Prevention [CDC], 2018a; Perikleous et al., 2018). According to the U. S. Food and Drug Administration (FDA, 2018b), e-cigarette use is becoming an epidemic engulfing the youth. It is noted that the recent National Youth Tobacco Survey (NYTS) showed an overall cigarette surge due to a rise in e-cigarette use (FDA, 2018a, 2019)

The CDC reported that the use of tobacco and tobacco products has continued to increase despite the public health implications of smoking and second-hand smoke (King, 2015). Smoking is the primary risk factor for various health issues including cardiovascular diseases, respiratory diseases, and cancer (Tai et al., 2018; U.S. Department of Health and Human Services [USDHHS], 2016). As reported by Acali and Kasap (2015), most people start smoking in childhood or adolescence, subsequently resulting in addiction. With increasing anti-smoking and awareness campaigns (CDC,

n.d.-c; McAfee et al., 2013), the use of conventional cigarettes has seen some decrease, but with the decrease in use of conventional cigarettes arises a new tobacco product, the e-cigarette, which has gained much attraction and increasing acceptance among the youth (CDC, 2016; King, 2015; Zare, Nemati, & Zheng, 2018). Although originally developed as a smoking cessation tool, the e-cigarette is now embraced by both cigarette users and non-smokers (Bunnell, et al., 2014; Mcmillen, Gottlieb, Shaefer, Winickoff, & Klein, 2014; Odani, Marynak, Armour, & Agaku, 2018).

Sociodemographic factors have been recognized as major contributors to illicit behaviors among adolescents (Giovenco, Lewis, & Delnevo, 2014; Whitesell, Bachand, Peel, & Brown, 2013). The problem, therefore, is that while we know that there is increased use of e-cigarettes among adolescents and that different sociodemographic characteristics are associated with e-cigarette use (Whitesell et al., 2013), we do not know how the sociodemographic factors are related to this changing trend in behavior of e-cigarettes use among the adolescent population in Texas. It is, therefore, the aim of this study to examine sociodemographic factors that are associated with e-cigarette use among adolescents in Texas. Early intervention can bring a positive social change for individuals, families, communities, and society at large.

Background

Prior to the federal regulation on all tobacco products in 2016 (FDA, n.d), the e-cigarette was the most common tobacco product used by adolescents in the United States

(CDC, 2015b). Although the e-cigarette was originally intended as an anti-smoking cessation tool, marketed as a healthier alternative to nicotine intake, there has also been an increased use of e-cigarettes among non-smokers (Mcmillen et al., 2014; Spindle et al., 2017; Wills et al., 2015). This is an indication that rather than the expected anti-smoking effect, there are other factors that promote the use of e-cigarettes among the population. The reason for this trend is, however, poorly understood (Ayers et al., 2017). Furthermore, according to a report by Cooper et al., (2016), there are different characteristics associated with e-cigarette use.

A report by the Tobacco Prevention & Cessation Commission (as cited in Prochnow, 2017) noted that between 2013 and 2014, the nationwide use of e-cigarette tripled among adolescents and young adults, while the recent NYTS for 2018 showed more cause for public health concerns (FDA, 2019). Although currently regulated in several countries including the United States (Kennedy et al., 2016; Marynak et al., 2017), online marketing of e-cigarettes exists and is providing access to this product (Tulsieram, Rinaldi, & Shelley, 2017). Thus, from initial intended use of e-cigarettes as a smoking-cessation aid, the product has become popular for the perception of improving an individual's social image due to its smokeless feature. It is furthermore easily accessible to youths, as it is less expensive than conventional cigarettes (Ayers et al., 2017; Marynak et al., 2017).

Reports further showed that in 2014, the use of e-cigarettes among the youth

surpassed the use of conventional cigarettes (Arrazola, 2015). A recent study has noted that the population-wide e-cigarette usage produces more harm than benefits (Soneji et al., 2018), and this is an issue of significant population health concern. The increasing use of e-cigarettes among adolescents has created a significant knowledge gap in the factors associated with this behavioral problem and the provision of appropriate interventions for the at-risk population. Therefore, there is need to understand what factors promote attraction of e-cigarette to the youth.

Analysis of the 2011-2017 NYTS, a cross-sectional school-based survey by the CDC and FDA Center for Tobacco Products (CDC, 2018a; Wang et al., 2018), indicated that e-cigarettes have been the most common tobacco product used by adolescents in the United States since 2014 (11.7%), followed by cigars (7.7%). According to the FDA, Center for Tobacco Products, from 2014 to 2017 (4 straight years), e-cigarettes remained the most used tobacco products among the youth (FDA, 2018b). "The Real Cost" public health education campaign, originally launched by FDA in 2014, was expanded in 2017 to focus on preventing e-cigarette use among the youth by conveying the message that "smokeless doesn't mean harmless" (FDA, 2017). The recent result from the 2018 NYTS has further shown a startling increase in e-cigarette use among adolescents (Cullen et al., 2018). Commenting on the dramatic increase of more than 1.5 million youth who reported current use (within the past 30 days) of e-cigarettes in the 2018 NYTS, the authors stated that the presentation of new e-cigarettes in appealing flavors make them

highly palatable to the youth (Cullen et al., 2018; FDA, 2019; Russell, Mckeganey, Dickson, & Nides, 2018).

Variations in the NYTS however exist among states due to population demographics (Cooper, Case, & Loukas, 2015; Krishnan-Sarin et al., 2015). For instance, Texas is a highly diverse state with Hispanic children and adolescents outnumbering other racial and ethnic groups more than in most states (Texas Department of State Health Services [TDSHS], 2019). The case of Texas is particularly disturbing; in a recent press release by the American Lung Association, Texas was reported as receiving failing scores for every aspect of tobacco control effort (Martinez, 2019). Furthermore, in keeping with the reporting requirement of the Texas Health and Safety Code, a current report on e-cigarettes from the Texas Department of State Health Services (TDSHS, 2019) noted that 32.5% of high school students and 11.3% of middle school students reported having ever used e-cigarette. In a study conducted across four metropolitan cities in Texas, namely Houston, Austin, Dallas/Fort Worth, and San Antonio, researchers from the University of Texas Health Science Center at Houston (UTHealth) reported that flavoring of e-cigarettes is strongly associated with its preference among youth and young adults (Meus, 2017).

Problem Statement

The use of tobacco products decreased between 2011 and 2017 from 24.2% to 19.6% among high school students and from 7.5% to 5.6% among middle school students

(CDC, 2018a; Wang et al., 2018). In the period of 2011 to 2017, a high rate of youth (58%, 2.1 million out of the 3.6 million) used e-cigarettes (FDA, 2018b). The recent statistics for 2018 (Cullen et al., 2018; FDA, 2018a) further showed a dramatic rise among high school students using e-cigarettes, from 11.7% in 2017 to 20.8% in 2018, which translates to a 78% increase within 1 year (Cullen et al., 2018; FDA, 2018a, & 2019). Similarly, among the middle school students using e-cigarettes, an upsurge from 3.3% in 2017 to 4.9% in 2018 was noted, an increase of 48% within 1 year (Cullen et al., 2018; FDA, 2019).

The increasing use of e-cigarettes by the youth can be affected by environment and individual characteristics (Dudovitz et al., 2017). There are different characteristics associated with e-cigarette use, such as demographics (Cooper et al., 2016), as well as societal factors, such as advertisements and flavoring of e-cigarettes by the tobacco companies (Ayers et al., 2017; Mccausland et al., 2019; Russell et al., 2018). From a public health perspective, practitioners and policy makers should be concerned about the impact of e-cigarette use among the growing population of vulnerable adolescents.

Purpose of the Study

The purpose of this study was to examine the magnitudes of association, if any, between the variables of age, gender, grade level, ethnicity, and race (independent variables) and e-cigarette use (dependent variable) among adolescents in Texas.

Secondary data analysis were conducted to examine quantitative data from the Texas Youth Tobacco Survey (TYTS).

Research Questions and Hypotheses

RQ1: Is there an association between age and e-cigarette use among Texas adolescents?

$H_0$1: There is no association between age and e-cigarette use among Texas adolescents.

H_a1: There is an association between age and e-cigarette use among Texas adolescents.

RQ2: Is there an association between gender and e-cigarette use among Texas adolescents?

$H_0$2: There is no association between gender and e-cigarette use among Texas adolescents.

H_a2: There is an association between gender and e-cigarette use among Texas adolescents.

RQ3: Is there an association between grade level and e-cigarette use among Texas adolescents?

$H_0$3: There is no association between grade level and e-cigarette use among Texas adolescents.

H_a3: There is an association between grade level and e-cigarette use among Texas adolescents.

RQ4: Is there an association between ethnicity and e-cigarette use among Texas adolescents?

$H_0 4$: There is no association between ethnicity and e-cigarette use among Texas adolescents.

$H_a 4$: There is an association between ethnicity and e-cigarette use among Texas adolescents.

RQ5: Is there an association between race and e-cigarette use among Texas adolescents?

$H_0 5$: There is no association between race and e-cigarette use among Texas adolescents.

$H_a 5$: There is an association between race and e-cigarette use among Texas adolescents.

Theoretical Framework for the Study

The theoretical base for this dissertation was Ajzen's (1991) theory of planned behavior (TPB) (LaMorte, 2016). TPB is a social and behavioral science theory that has been extensively applied to study behavioral problems and incorporates both social influences and personal factors (Topa & Mariano, 2010). According to Ajzen (1991), intentions are indications of how much effort and how willing people are to perform

certain behaviors, in this case, to avoid e-cigarette use. In this construct, it is believed that the strength of the intention will determine the likelihood of using or avoiding e-cigarette use. According to TPB theory, intentions are a function of three independent constructs. These are the individual's attitude toward e-cigarette use, the subjective norms that can influence the individual's action (including peers and family), and the perceived behavioral control that the individual can have over e-cigarette use, which will serve as points for intervention. This theory is among the most effective approaches for predicting behaviors (Bilic, 2005). This theory will guide the development of interventions that re-direct adolescents towards making behavioral change to cease e-cigarette use.

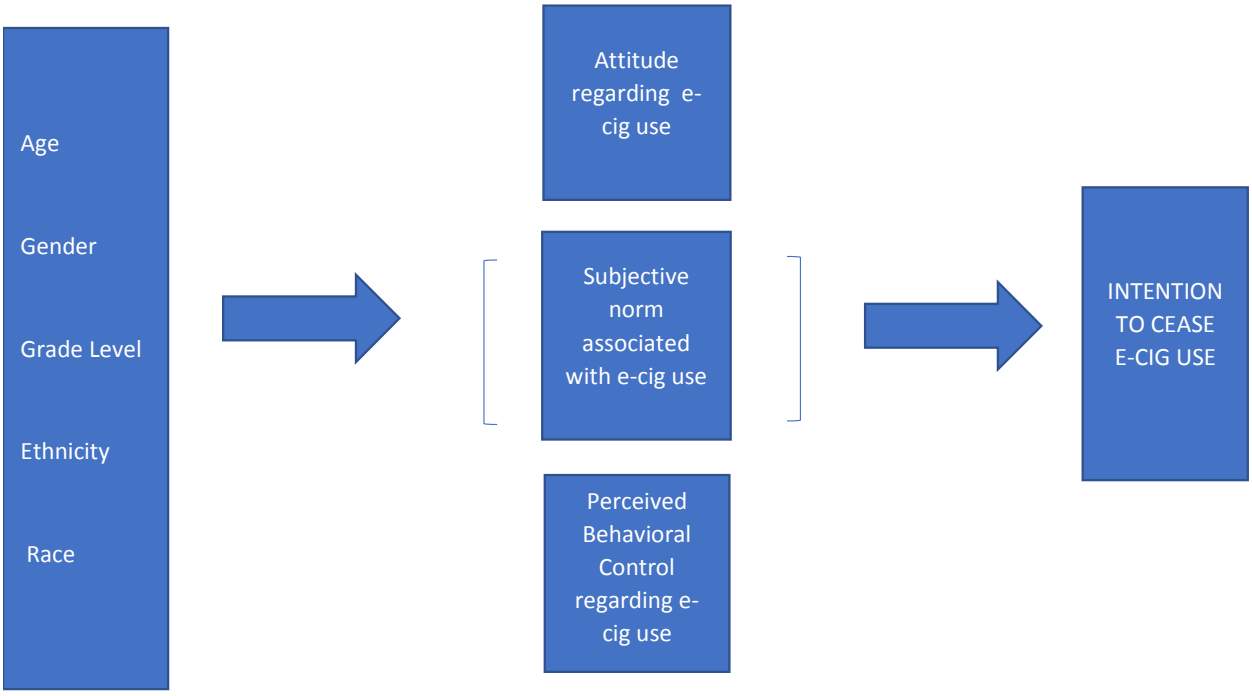

Figure 1. Model of the Theory of Planned Behavior for mitigating e-cigarette use.

Nature of the Study

The research questions drive the method. Thus, the methodological approach for this dissertation was quantitative, which was used for looking at the relationship between variables (Creswell, 2014). This approach was also used to collect information from a large group, such as in a survey (Dutra & Glantz, 2014). The independent variables for this study included race, ethnicity, gender, grade level, and age, while the dependent variable was e-cigarette use. These variables were extracted from the data originally

collected through self-reported responses from Texas YTS and statistically analyzed using binary logistic regression.

Definitions

Adolescence is the developmental period between ages 10 and 19 and it is characterized by growth, decision making, and changes that are critical in transiting from childhood to adulthood (World Health Organization, 2017). The adolescent stage is also characterized by changing social relationships with parents and peers (Pentz et al., 2014).

Attitude is the extent to which an individual considers a behavior to be favorable or unfavorable, and the more an individual considers a behavior to be favorable, the greater the likelihood of undertaking that behavior (Asare, 2015).

Behavioral control is an inherent perception of the individual regarding his/her ability to desist from or to perform a behavior (Mazloomy, Jadgal, & Movahed, 2017).

Behavioral intention is the motivation that influences a behavior; the stronger the motivation to undertake a behavior, the more likely it will be for the individual to undertake the behavior (Allahverdipour et al., 2007).

Current e-cigarette use is defined as the use of at least one e-cigarette within the past 30 days prior to the survey (Cullen et al., 2019; Copper et al., 2015), while *lifetime e-cigarette use* refers to ever using an e-cigarette, even one or two puffs, in ones' life (Park et al., 2017). Similar definitions of *lifetime* or *current smoking* have been used in previous studies (Peters et al., 2013; Su et al., 2015).

Dependent variables (DV) are the variables that can be changed due to influence of other factors (Helmenstine, 2016). Also known as outcome variable, it is the variable of research interest (in this case, e-cigarette use).

Electronic cigarettes (e-cigarettes) are cartridge containing devices which are operated by a battery to heat up solutions of various components, including flavors, glycerin, propylene glycol, and nicotine, to produce aerosolized vapor, but without burning tobacco (Alawsi et al., 2015; Alcala et al., 2016; Drummond & Upson, 2014). E-cigarettes are non-combustible tobacco products or vaporizers, and the users are referred to as vapers (Alawsi et al., 2015).

Independent variables (IV) are factors that are believed to affect the dependent variable. They are variables that stand alone and are not changed nor influenced by surrounding factors (Helmenstine, 2016). Sociodemographic factors such as race, ethnicity, gender, age, and grade level are the IV for this study. They provide important information regarding healthcare disparities and e-cigarette use that can be implemented in developing targeted health interventions (Cooper, et al., 2015; Moran et al., 2019; Perikleous et al., 2018).

Subjective norm refers to the influence that social relationships (such as peers, significant others, or family) have on an individual which promote or prevent his/her undertaking a behavior (Bashirian, Hidarnia, Allahverdipour, & Hajizadeh, 2012).

Theory of planned behavior (TPB) is a social and behavioral science theory that

predicts an individual's intention to engage in a behavior at a specific time and place. It posits that individual behavior is driven by behavioral intentions, thus identifying the individual's intention as the immediate predictor of the behavior that follows (LaMorte, 2016).

*Weighting i*s a mathematical procedure that makes data representative of the population from which it was drawn (Texas DSHS, n.d.). Texas YTS data are representative of all public middle and high school students in grades 6 through 12 in the state of Texas.

Assumptions

In this study, the following assumptions were made:

1. Participants in this study, who were adolescents enrolled in middle and high schools in Texas involved in the TYTS, were representative of the adolescent population in Texas.
2. Participants provided truthful responses regarding lifetime and current e-cigarette use.
3. Confounding variables, such as area of residence and socioeconomic status, did not influence the association between the variables being studied.

Scope and Delimitations

This study was a secondary data analysis of a survey data originally collected by the Texas DSHS and PPRI. The population of study was adolescents enrolled in Texas

public middle and high schools during the spring of 2018 who voluntarily consented to participate in the survey. Variables in the original study were used to examine the relationship between sociodemographic characteristics and e-cigarette use among the target population. This relationship was explored using Ajzen's (1991) TPB, which is used to explain health behaviors that can be controlled by individuals (LaMorte, 2016).

Limitations

This study was a secondary data analysis of data from the YTS of Texas adolescents and may not be generalizable to all adolescents across the United States. Confounding variables may also not be equally distributed among the study participants, and this might affect the interpretation of the findings. This study was a cross-sectional design; therefore, a cause-and-effect cannot be delineated.

Data from surveys, such as the secondary data being used for this research, were based on self-report and not objectively collected by me. Hence the accuracy of the data could be impacted by the accuracy of participants' responses and their memory recall. The Texas YTS is a school-based survey, so it represents only adolescents enrolled in schools. Thus, adolescents who were not enrolled in school, were absent from school, or were in correctional facilities were not included in the data set, and relevant data from these individuals who are potential high risk for ECU were not captured. Furthermore, the survey did not have a 100% response rate (Copper et al., 2015; Cullen et al., 2018), and as such response bias from the participants could affect the findings.

Significance of the Study

Despite the shift from conventional to e-cigarette use, there is a scarcity of information on the role of social and demographic factors in this paradigm shift. Reports have shown that various characteristics influence preference in use of tobacco products (Chaffee, Couch, & Gansky, 2017; Cooper et al., 2016). Furthermore, attraction and accessibility of e-cigarettes to adolescents outweighs the federal regulations, as the product packaging by manufacturers (Morean et al., 2018) and online advertisements (Agaku et al., 2014; Bandura, 2016; Clark et al., 2016) specifically target the adolescents.

The public health implication of this paradigm shift towards preference of e-cigarettes among the youth cannot be overemphasized. This study has the potential to help the development of initiatives to prevent the risk-taking behaviors of e-cigarette use by the vulnerable adolescent population. As noted in the Surgeon General's Report (U.S. Department of Health and Human Services [USDHHS], 2016), there is no safe use of tobacco and e-cigarettes in any form among adolescents. Accurate identification of the factors associated with e-cigarette use among the youth can be central in effectively implementing sustainable public health prevention interventions that will result in positive population health outcomes.

Summary

The provision of appropriate, target-specific intervention for mitigating e-cigarette use among the youth would be an effective way of preventing the public health menace

associated with this behavioral problem. In order to produce a sustainable behavioral change among the youth, it is pertinent to examine the factors that influence the development of this behavior of using e-cigarette among this vulnerable population. Social structural factors include economic, social, and organizational environments that can facilitate the adoption of risky behaviors among a population (Mehrabi et al., 2016).

The findings from this dissertation could provide evidence for the development of policies that can be translated into practice, as well as for the development of appropriate behavioral interventions for the mitigation of adolescent e-cigarette use. Preventing e-cigarette use among adolescents and its negative effects would consequently promote positive change in the individuals and society at large. The data generated would provide information about e-cigarette use and the impact of social and demographic factors.

Chapter 2: Literature Review

Introduction

Globally, e-cigarette use among adolescents has remained a public health challenge (Cullen et al., 2018; Fairchild, Bayer, & Lee, 2019; Rohde et al., 2018). In the United States, the reports from the NYTS released annually by the Food and Drug Administration in conjunction with the Centers for Disease Control and Prevention had continued to show increasing use of e-cigarettes by the adolescents, with over 5 million youth reporting current use and over 1 million reporting daily use (Cullen et al., 2019; FDA, 2019).

Earlier research showed that adolescents in the state of Texas reported a life-time e-cigarette use of 23.6% and current e-cigarette use of 14.0% (Cooper et al., 2015), with average current e-cigarette use prevalence of 19.1% for high school students and 7.9% for middle school students, which are higher than the national average of 13.4% for high school students and 3.9% for middle school students (Arrazola et el., 2015; Cooper et al., 2015). Also, of importance is that adolescents in Texas represent approximately 9.5% of the total adolescent population in the United States (Cooper et al., 2015). Recently, a report from the Texas Department of State Health Services (TDSHS, 2019) stated that about 32.5% of high school students and 11.3% of middle school students have used e-cigarettes. Multiple press releases from the American Lung Association further showed

the need to strengthen tobacco control efforts in Texas (Richardson, 2017; Martinez, 2019).

Several research studies have been published on the increasing prevalence of e-cigarette use among adolescents (Cooper et al., 2015; Cullen et al., 2019). There is, however, scarcity of information on the magnitude of association between e-cigarette use and factors associated with its use. With the increasing prevalence of e-cigarette use among adolescents, it was of great public health importance to explore these relationships. The purpose of this study was to examine the relationships between e-cigarette use and sociodemographic characteristics among adolescents in Texas. Understanding how large the magnitudes of association between sociodemographic characteristics and e-cigarette use among the adolescent population are can help to provide better information on the severity of the problem and can serve as a benchmark for developing appropriate target-specific interventions.

In this chapter, I discuss the literature search strategy, theoretical foundation, and literature review related to key variables such as e-cigarette use and socioeconomic characteristics, then provide a summary of the chapter.

Literature Search Strategy

In conducting the literature search, I used the Library Health Sciences database to obtain peer-reviewed literature, while grey literature was used to obtain unpublished information. An exhaustive literature search was conducted using the University Library

database, employing various search strategies and combinations of keywords. In one strategy, on the Walden Library home page, I clicked on "Search by Subject" and chose "Health Sciences," clicked on "Health Sciences Databases," then "ProQuest Health and Medical Collection database," and entered the search terms/ keywords *Electronic Cigarettes, Adolescents, Texas, Public Health, Quantitative studies,* and *Theory of planned behavior*. In another search strategy, I used the Academic Search Complete (EBSCOHost) database, employing the search terms *Electronic cigarette, Vaping, Factors, Texas, Adolescents,* and then *E-cigarettes*, *Adolescents, Quantitative studies,* and *Public Health.* Since e-cigarettes were developed in the early 2000s, the initial search was conducted from 2004 to date. This provided much bibliographic data on the topic being studied. The bibliographies were screened to narrow the reference lists to variable of interest. Subsequent searches were from 2014 to date in order to obtain current data on the topic. All searches were limited to publications in English language.

Relevant theses and dissertations available electronically were also reviewed. Furthermore, Google Scholar was used to obtain articles and reference lists of related articles, which were also examined to obtain additional literatures. In addition, other websites of relevance to substance abuse and the study population such as the websites of the Center for Disease Control and Prevention, the Food and Drug Administration, as well as the Texas Department of State Health Services were regularly visited for updates. Since this research involved secondary data analysis, books and articles on quantitative

data analysis were also consulted. Literature was also thoroughly examined to determine the most appropriate framework for this study.

Theoretical Foundation

The theoretical foundation for the study is Ajzen's TPB (1991), which originally started as the theory of reasoned action (TRA). This theory is used to explain health behaviors that individuals can control (Glanz, Rimer, & Viswanath, 2015). It posits that the intention to undertake a behavior is a function of three independent constructs: attitude towards behavior, subjective norm, and perceived behavioral control (LaMorte, 2016). Intentions are indications of how much effort people are willing to expend and how willing people are to perform certain behaviors with consideration of the motivational factors that influence such behaviors (Ajzen, 1991; LaMorte, 2016). For this study, intentions represent how willing adolescents were to avoid using e-cigarettes, with consideration of the motivational factors that influence e-cigarette use among this population. Thus, the strength of the intention determined the likelihood of using or avoiding e-cigarettes (LaMorte, 2016). TPB has been widely applied to examining problem behaviors, especially among adolescents (Abad et al., 2017; Higgins & Conner, 2003; Karimy et al., 2015; Macy et al., 2012; Su et al., 2015; Topa & Mariano, 2010).

Many problem behaviors are reportedly initiated during adolescence, as this population visualizes these behaviors as steps to becoming adults (Evans, 2003). According to Allahverdipour and associates (2007), some risky behaviors need prior

intent to undertake, but most adolescent risky behaviors (such as substance abuse) are often initiated unintentionally, as the behaviors are usually triggered by precipitating factors or social situations that are conducive for undertaking the behaviors, such as age, gender, and race (Giovenco, Lewis, Delnevo, 2014; Park et al. 2017). The authors further reported that the motivation to avoid the risky behavior would be deliberate. Behavioral intention is the motivation that influences a behavior; the stronger the motivation or intention to undertake a behavior, the more likely it will be that the individual will undertake the behavior (LaMorte, 2016; Topa & Moriano, 2010).

In the TPB, perceived control over behavior determines behavioral intention and attitude. Thus, motivation to carry out an action can be affected by belief in the ability to undertake the action (Mazloomy, Jadgal, & Movahed, 2017). Considering that risky behaviors constitute a syndrome, an adolescent who engages in one risky behavior is more likely to engage in another risky behavior. Bandura, Adams, & Beyer (1977) applied the concept of perceived behavioral control to preventing excessive gambling when a gambler is losing. Eggleston et al. (2011) applied the TPB to study yoga attendance and reported that intention strongly predicts the behavior. Asare (2015) applied the TPB to determine condom use among college students using a 32-item cross-sectional survey and also concluded that behavioral attitude, perceived control over the behavior, as well as subjective norm strongly predict an individual's intention regarding condom use behavior. Similarly, in a recent study, Mazloomy, Jadgal, & Movahed (2017)

also applied the TPB to examine drug abuse behaviors among adolescents using a Likert-style scale continuum format in a 49-item questionnaire to measure each component of the TPB (behavioral intention, attitude towards behavior, subjective norm/peer influence, and perceived behavioral control). Responses generated were analyzed to determine the magnitude of the relationships between the variables and the constructs of the TPB. These studies have supported the predictive validity of the TPB.

Literature Review Related to Key Variables and/or Concepts

Description of Studies Related to the Constructs of Interest

Following its manufacturing in the early 2000s and its introduction into the United States market in 2007, the e-cigarette has been unregulated, making it readily accessible and increasing its popularity, especially among the youth (Prochnow et al., 2017; Singh et al., 2016). Having recently been regulated by the United States Food and Drug Administration in 2016 (FDA, 2016; Mamudu et al., 2019), e-cigarettes nevertheless remained accessible, especially to the youth, through various sources, including but not limited to internet sales/ advertising for which the youth are highly vulnerable (Hyman & Brown, 2017). As stated by the U.S. Surgeon General, the use of any form of nicotine-containing substance by the youth is unsafe (USDHHS, 2016).

The NYTS monitored adolescent e-cigarette use starting in 2011 (King, 2015). Prevalence of use doubled from about 3.3% in 2011 to 6.8% in 2012 (Corey et al., 2013). Dutra and Grantz (2014) reported that the life-time prevalence of e-cigarette use among

adolescents doubled from 3.1% in 2011 to 6.5% in 2012, while the current use prevalence similarly increased from 1.1% in 2011 to 2.0% in 2012. Prevalence of current tobacco use among high school students was noted to decline from 15.8% to 9.2% between 2011 and 2014 (Arrazola et al., 2015; Barrington-Trimis et al., 2016) with an associated prevalence of e-cigarette current use remarkably increasing from 1.5% to 13.4% between 2011 and 2014 (Arrazola et al., 2015).

In this study, the independent variables were gender, ethnicity, race, age, and grade (education) level, while the dependent variable was e-cigarette use. Researchers have linked several factors to e-cigarette use among adolescents. One such factors is demographic characteristics. According to CDC data, the prevalence of current and lifetime smoking in the United States varies by gender, race/ethnicity, economic status, age, and level of education (CDC, 2015b). The CDC (2015b) reported the prevalence of smoking according to gender: men is 18.8% and women is 14.8%; according to race/ethnicity as: American Indian/Alaska Natives (non-Hispanic) is 29%, Whites is 18.2%; Blacks is 17.5%, Hispanics is 11.2%, and Asians (non-Hispanic) is 9.5%; by economic status: below poverty level is 26.3% while above poverty level is 15.2%; by age: 18 to 24 years of age is 16.7%, 25 to 44 is 20.0%, 45 to 64 is 18.0%, while 65 years and older is 8.5%; and by level of education: less than high school is 22.8%, GED is 43.0%, high school graduate is 21.7%, some college education is 19.7%, associate degree is 17.1%, and undergraduate degree is 7.9% (CDC, 2015a).

Still, the prevalence of e-cigarette use in the past 30 days from the NYTS was 13.4% among high school students in contrast to 5.1% among young adults aged 18-24 years and 4.7% among older adults aged 25-44 years (Arrazolla et al., 2015). Based on the most current NYTS, the prevalence of current e-cigarette use was highest among high school students (27.5%) and followed by middle school students (10.5%) (Cullen et al., 2019). Among current e-cigarette users, about 34.2% of high school students and 18.0% of middle school students were frequent users, while 63.6% of high school students and 65.4% of middle school students were exclusive e-cigarette users (Cullen et al., 2019).

Park et al. (2017) reported that current and lifetime e cigarette use were significantly associated with male gender, higher grade level, higher weekly allowance, urban residential areas, and having friends who smoked. The authors further noted that current e-cigarette use was significantly associated with other health risk behaviors such as drinking, drug use, and sexual intercourse (Park et al., 2017). Globally, e-cigarette use among adolescents was associated with increased perceived stress level, parental smoking, and friend's smoking (Khoury et al; 2016). In a study of Korean adolescents, the authors reported e-cigarette use to be associated with both cigarette smoking and smoking cessation (Lee et al., 2014).

Presenting the facts from research studies, the Surgeon-General reported that higher use of e-cigarette is found among male, White non-Hispanics, while lower e-cigarette use was found among female, African American non-Hispanics (USDHHS,

2016). Other studies have also reported sociodemographic differences in e-cigarette use with main emphasis on differentiating between Whites and Blacks (Dutra & Glantz, 2014; Lippert, 2015; Singh et al., 2016).

Analyzing the pattern of tobacco use among different races/ethnic groups, Wang et al. (2018) reported that non-Hispanic white high school students had the highest usage of e-cigarettes (14.2%,) followed by Hispanics (10.1%), while non-Hispanic blacks had the highest usage of cigars (7.8%). The reason for this disparity among races is not clearly understood, but it has also been reported that several factors contribute towards promoting tobacco use among the youth, including extensive advertising by tobacco companies and flavoring the e-cigarette to make it addictive (Ayers et al., 2017; CDC, 2017; Litt, Duffy, & Oncken, 2016; Wang et al., 2018).

Given the highly diversified populations of immigrant communities in Texas, it is important to understand the impact of demographic characteristics on e-cigarette use. Previous research in Texas examined the prevalence of e-cigarette and dual cigarette use across the population (Cooper et al., 2015). With the continuing upsurge of e-cigarette use among the adolescents (FDA 2019), the present study has examined how e-cigarette use among adolescents in Texas (as the dependent variables) is influenced by sociodemographic characteristics of the participants (as independent variables) using recent data from TYTS. It is crucial to understand the impact of these variables on e-

cigarette use in order to implement appropriate target-specific health promotion programs that would effectively engage the target audience.

Health Effects of E-cigarette use

With the introduction of non-combustible cigarettes such as e-cigarettes as a safer alternative to combustible tobacco, the harm associated with cigarette use was not reduced (CDC, 2015a). The public health burden of smoking remained extremely high, especially among youth (USDHHS 2018). The e-cigarette has continued to gain increasing popularity among the adolescent population and has remained the most common tobacco product used by this population since 2014 (Cullen et al., 2019; USDHHS, 2018). Globally, the use of e-cigarettes has continued to rise among the adolescents (Jiang, Wang, Ho, Leung, & Lam, 2016; Kennedy, Awopegba, León, & Cohen, 2016; Khoury et al., 2016; Montreuil et al., 2017; Thatcher, 2015). Controlling the epidemic of adolescent e-cigarette use is a priority (FDA, 2018a). According to the U.S. Surgeon General, the adolescent brain is still developing and can thereby be adversely affected by the exposure to nicotine products contained in e-cigarettes (USDHHS, 2016).

There has been growing concern over the health effects of e-cigarettes and growing controversy regarding their usefulness as a smoking cessation tool (Alawsi et al., 2015). In their clinical review, Alawsi et al. (2015) reported that e-cigarettes are modestly effective for smoking cessation among current conventional smokers, as evidenced by

randomized controlled trials in which nicotine e-cigarette users had a 7.3% reduction in smoking conventional cigarettes in comparison to other groups with smoking reductions of 5.8% (patches) and 4.1% (placebo e-cigarettes). This clinical review further noted that the aerosol generated from e-cigarettes is generally less toxic than the smoke from conventional cigarettes. On the contrary, it has also been reported that the use of e-cigarette is strongly associated with conventional cigarette use as well as use of other tobacco products (Alcala, 2016; Camenga et al., 2018), as well as with previously non-smoking (Bunnell et al., 2015; Wills et al., 2016). The health implications of e-cigarette use over a long time are unknown (Camenga et al., 2018). As mentioned above, the adolescent brain is still developing, so any use of nicotine-containing substances by adolescents cannot be considered safe (USDHHS, 2016). An estimated 443,000 adults in the United States die annually from cigarette use (King et al., 2012), and an estimated 5.6 million youth will die prematurely from a smoking-related illness at the current rate of tobacco initiation (USDHHS, 2014).

Cigarette use is a major risk factor for respiratory infections and for many of the leading causes of death, including COPD, heart disease, and lung cancer (Drummond & Upson, 2014). E-cigarette use is a major risk factor for cardiovascular and lung diseases (Bertholon et al., 2013; Ferkol & Schraufnagel, 2014; Papathanasiou et al., 2014), as well as some forms of cancer and contribute to over half of all smoking-related deaths (Glantz & Bareham, 2018; Tai et al., 2018). Aerosols from e-cigarette can deposit particles of

nickel, chromium, and tin into the lungs, which could result in respiratory toxicity (Grana, Benowitz & Glantz, 2014; Rohde et al., 2018). In an in-vitro study, the researchers noted that the exposure of cells to e-cigarette aerosol extracts resulted in the suppression of cellular antioxidant defenses, leading to significant DNA damage in the cells (Ganapathy et al., 2017). This indicates the potential for cancer risk from long term exposure to e-cigarettes. The U.S. Surgeon-General Report (USDHHS, 2016) also noted that addiction from the nicotine content of e-cigarette can lead to the use of other harmful substances such as cocaine and methamphetamine (FDA, 2018a; Kamat & Van Dyke, 2017).

Other Factors Associated with E-cigarette use

There are several other factors that has been reported to increase e-cigarette use by the youth. One such factor is advertisement (Agaku et al., 2014; Camenga et al., 2018; Collins et al., 2019; Huang et al., 2014; King, 2015). According to King (2015), e-cigarette manufacturers have consistently used several tricks that have been used for advertising conventional cigarettes to also promote e-cigarettes and they have been particularly directed to the youth. King (2015) reported that between 2011 and 2015, approximately 18 million youth in the United States were exposed to e-cigarettes through advertising.

Flavoring of e-cigarettes is another factor in adolescent e-cigarette use, as this is appealing to youth and drives them to use the product, while also keeping them using it

once they have tried it (Litt, Duffy, & Oncken, 2016; Morean et al., 2018; Zare, Nemati, & Zheng, 2018). E-cigarettes have evolved over the years from the disposable first generation non-flavored model to newer refillable models (Brown & Cheng, 2014). Consisting of three main components, e-cigarettes contain a liquid solution (e-liquid), a heating element (for vaporizing the liquid solution into an inhalable aerosol), and a battery power source (Alawsi et al., 2015; Brown & Cheng, 2014). The e-liquid component contains flavored nicotine or other substances, and this holds high appeal to the youth (Ayers et al., 2017). E-cigarette awareness and use has grown over the years (King, 2015; Pearson et al., 2012; Wackowski, Bover, & Delnevo, 2015). Studies have reported that the use of other tobacco products can also lead to e-cigarette use, a term referred to as dual use (Cooper et al., 2016), while others have also noted that some people originally embraced e-cigarettes as a smoking cessation aid but subsequently use them to promote social image (Ayers et al., 2017).

Behavioral problems usually occur among peers, and peer usage and preferences can also affect e-cigarette use (Hwang & Park, 2016). Considering the influence of significant others (subjective norms) on the occurrence of behavioral problems, researchers noted that parental and peer influences are potential factors in smoking behaviors among adolescents (Vitoria, Salgueiro, Silva & Vries, 2009). Acarli and Kasap (2015), Hwang and Park (2016) and Kinnunen, Ollila, Lindfors and Rimpelä (2016) addressed the influence of peer cigarette smoking on the initiation of e-cigarette use

among adolescents, noting that friends' cigarette smoking strongly predicted smoking initiation among adolescents. In a qualitative study that examined the beliefs of teenage male e-cigarette users in Houston, Texas, regarding their use of e-cigarette, Peters et al. (2013), reported that peer approval has a significant effect on adolescent e-cigarette use. In this study, participants reported that the e-cigarette has a high social approval among friends. Other reports also noted that social norms are crucial in understanding social behaviors among adolescents (Bauman & Ennett, 1996, Gifford-Smith et al., 2005; Gilman et al., 2009; Su et al., 2015; Unger et al., 2002).

Summary and Conclusion

In this chapter, I have discussed the literature search strategy, theoretical foundation, and literature review related to key variables for e-cigarette use among adolescents. E-cigarettes use is associated with several health problems and the long-term implications is unknown. Use of e-cigarette by the adolescents remains on the rise as manufacturer continue to target this population in advertisements and by making the product palatable to them.

The public health problem of e-cigarette use among adolescents remains on the rise globally. Understanding the magnitude of association between sociodemographic and individual characteristics and e-cigarette use among the adolescent population is critical for developing sustainable public health interventions to address the problem of e-cigarette use among adolescents.

Chapter 3: Methodology

Introduction

This study was non-experimental research, using de-identified secondary data to examine the factors associated with e-cigarette use among adolescents in Texas. Despite the increasing popularity of e-cigarettes, especially among the youth (Cullen et al., 2019), there is limited research on the impact of individual factors or societal factors on e-cigarette use among the vulnerable youth population. Findings from this study may lead to the development of interventions to prevent e-cigarette use and decrease the resultant morbidity and mortality among individuals who initiate smoking at an early age (United States Department of Health and Human Services, 2016). These data are needed for developing targeted audience-specific policies that would mitigate the long-term harmful effects of these products in the youth.

Notably, tobacco use is a major risk factor for death associated with heart and respiratory diseases, as well as being the leading cause of morbidity and mortality in the United States and globally (Drummond & Upson, 2014). King (2015) noted that about 443,000 adults die annually from tobacco use. The United States Surgeon General reported that if the current rate of tobacco uses continues, an estimated 5.6 million adolescents will die prematurely from smoking-related causes (United States Department of Health and Human Services, 2016).

The purpose of this study was to investigate the associations between e-cigarette use and sociodemographic characteristics, using a quantitative design to analyze data from the 2018 Texas YTS. This chapter describes the study design, research methodology, sampling and recruitment procedures, study instrumentation, data analysis plan, quality controls, including validity and reliability, as well as ethical considerations for the protection of study participants.

Research Design and Rationale

The independent variables for this study are age, gender, grade level, ethnicity, and race. The dependent variable is e-cigarette use. Residential area and socioeconomic status were used as potential covariates. This study used secondary data analysis to examine sociodemographic characteristics of participants and their relationship with e-cigarette use. It examined how e-cigarette use among adolescents in Texas (as the dependent variables) is influenced by sociodemographic characteristics of the participants (as independent variables) using recent data from the TYTS. Secondary data from cross-sectional surveys of public middle and high school students were analyzed with a goal of determining the influences, if any, of sociodemographic characteristics on the use of e-cigarettes by adolescents. Binary logistic regression analysis was conducted to determine whether associations exist between the independent predictor variables and the outcome variable.

The original data collection was conducted with a survey, using a cross-sectional design. A survey is a non-experimental design appropriate for collecting self-reported information regarding behaviors and attitudes, as well as sociodemographic data from groups of people (Cox, 2016; Fink, 2009). The survey instrument is the tool used to collect the data, such as a questionnaire or interview (Cox, 2016; Fink, 2009). Cross-sectional approach is used to determine the prevalence of a health issue at a specific time in a population (Mann, 2003)

The cross-sectional approach is generally less expensive as it does not involve control and intervention groups nor follow-up of participants. On the contrary, this approach can be used for studying multiple outcomes at the same time. For public health planning and policy development, a cross-sectional approach further provides fast reliable data collection at one time and analysis within a short time frame, while limiting ethical issues as there is no deliberate exposure of participants to treatment (Mann, 2003). However, using a cross-sectional approach does not enable the determination of cause and effect, since collection of data is done at only one point in time, without follow-up.

Methodology for the Original Study

The data used for this study were originally collected using the TYTS conducted by the Texas Department of State Health Services (TDSHS) and Public Policy Research Institute (PPRI) of the University of Texas A&M, making this study a secondary data analysis. Through email communication with the TDSHS, I was provided with the study

methodology report and granted access to use the archived data. The recent TYTS was conducted in the spring of 2018 under a contract between the TDSHS and the PPRI.

To ensure adequate community participation across the state, the TDSHS funded nine coalition areas in the state. These coalition areas were tasked with (a) conducting in-depth community tobacco needs assessments regarding the use of tobacco and illnesses related to tobacco use that affect Texas residents; (b) developing the capability needed to provide education that will address tobacco-related community needs; and (c) planning, implementing, and evaluating evidence-based tobacco prevention strategies (PPRI, 2018).

Target Population and Size

The participants are Texas adolescents ages 11-18 in grades 6 through 12. According to the U.S. Census Bureau (n.d.), the Texas population is more than 28 million, with individuals under 18 years accounting for about 7 million. A report on Texas public school enrollment showed that enrollment for the year 2018-2019 totaled approximately 5.4 million students from grades 6 to 12 (The Texas Tribune, n.d.). To obtain an accurate representation of all public schools in Texas, probability sampling was used for school selection. A total of 15,096 students enrolled in public schools across Texas participated in the 2018 TYTS.

Sampling and Sampling Procedures

Random selection was used to recruit participants for the original survey. In the original study, two-step sampling designs were used. The primary sampling units (PSU) were all public school in Texas while the secondary sampling units (SSU) were the classes. All public schools in Texas were targeted. To accurately reflect the general population of adolescents in Texas, schools were selected using probability sampling, followed by random selection of classrooms from participating schools. By using probability proportionate to size sampling, the probability of a school's selection was be in proportion to the school size (PPRI, 2018). Finally, all students in selected classrooms were eligible to participate voluntarily as the students and/or their parents were invited to actively accept to participate or decline to participate without any negative implication on the students' academics. Classroom sessions offering core courses were used to capture all eligible students.

Inclusion and exclusion criterion were applied to the selection of participants. To be included into the study, participants were Texas students in grades 6 through 12, in participating schools who voluntarily consented to participate in the study or received written authorization from a parent to participate in the study. On the other hand, individuals were excluded from participating in the study if they were not Texas students or not in grades 6 to 12, or if they did not voluntarily consent or provide written parental authorization to participate.

Procedures for Recruitment, Participation, and Data Collection in the Original Survey

Slightly different sampling process were employed for coalition area schools and noncoalition area schools (state sampled schools). For the coalition areas, all districts in the nine-coalition area were targeted for participation and campuses from the districts that opted to participate were randomly sampled for inclusion into the survey. All 80 districts in the coalition areas were invited, out of which 26 districts with a total of 53 campus accepted to participate. In these campuses, a maximum of nine classroom per grade level were randomly sampled into the coalition sample. PPRI collaborated with staff members in the coalition areas to assist with distributing letters of support for the survey to schools and to also connect directly with the school districts.

For state sampled (non-coalition), schools were directly notified by PPRI and requested to send in their basic participation form via fax or email. Furthermore, the PPRI coordinator made several connections by email and phone to encourage school participation as this ensured accurate representation of all public schools in Texas. Unlike the coalition schools in which all districts were invited to participate, the schools in the non-coalition areas were sampled for selection using probability proportionate to size (PPS) sampling, in which the chance of a school selection is relative to the school size. Similarly, since there are less schools in rural and border areas, the selection of schools in these areas was increased, while less schools were selected from urban schools. In the

non-coalition areas, out of a total of 3,313 eligible schools, 200 schools were sampled, 53 schools accepted to participate in the survey, and three classrooms per grade level were selected for inclusion into the survey.

Following acceptance of support by schools, classrooms within the district school were randomly sampled for inclusion into the survey. To include a classroom, a master list of all classes for grades 6 through 12 was obtained from the schools. Based on the data collection method used by the school (paper/pencil method or online/computer), the survey coordinator selected classes either by class period or by core subject in the case of paper/pencils data collection or solely by core subject class if using online data collection method. Next, the coordinator obtained from each school the list of all teachers responsible for either the selected class session or the subject. Using random selection of classes, PPRI selected classrooms until each grade level was completely randomly selected.

Sampling Frame and Sample Size

The Texas Education Administration (TEA, n.d.) database, which houses the record of all public schools in Texas, served as the sampling frame for the original survey. According to CDC (n.d.-b), the sampling size determination is guided by historical participation rates of the State Youth Tobacco Survey since the initial pilot survey in 1998. Different states conduct the State Youth Tobacco Survey with technical assistance from CDC. Texas was among the first states that conducted the initial State

Youth Tobacco Survey in 1998 and has been conducting it every 2 years (PPRI, 2018). Using the CDC model for Youth Behavioral Survey, weighted data is used to ensure that the overall response rate from a state survey is representative of youth tobacco use and can be generalized to the entire state youth population. A weighted overall response rate of 60% is used for the state surveys, and this is derived as a product of the school response rate and the student response rate, each response being calculated by dividing the number of participation schools (or participating students) with the number of selected/ eligible schools (or selected students). According to the Office on Smoking and Health (n.d.), this weighting is based on the premise that an overall response rate of 60% eligible participants would reduce the amount of non-response error in the data, taking into consideration that not every school or every student would be willing to complete the survey. The original data collection for the State Youth Tobacco Survey is designed to attain state estimates of 95% confidence level with a precision of +/- 5% (Office of Smoking and Health, OSH, n.d.).

In the TYTS, coalition schools have a guaranteed inclusion into the survey (a probability of 1) while the state (non-coalition) schools are sampled by random chance, thereby having a lower probability of inclusion than the coalition schools. In the original data collection, the researchers created campus weights for both size of campus and probability of selection in order to provide appropriate chances of selection for state (non-coalition) schools as for the coalition schools and ensure that appropriate

representation is made from all schools, whether by guaranteed inclusion or by random sampling. Furthermore, weighting was used to ensure that the percentage of students sampled in each school (based on the school size) provides an appropriate representation of the whole school in the final estimate (Public Policy Research Institute [PPRI], 2018). These adjustments were made in the original data collection by weight stratification based on students' grade and race/ethnicity distributions (PPRI, 2018). Thus, a multi-stage weight calculation (WT2) was used to generate the final sample size.

Data Collection Procedures in the Original Study

Following confirmation of school participation and classroom selection, a parental notification document was sent to the parents of each student in a selected classroom at least 2 weeks prior to the survey. This document contained information regarding the study background, risks/benefits of the study to the participants, privacy/confidentiality issues, voluntary participation/ withdrawal, and contact information. After receiving signed parental notifications, the survey coordinator provided the materials for the school survey administration for each classroom to the school coordinator. Each student using online methodology was provided with a unique alphanumeric survey code to access the online survey website. Following administration, the survey instruments were sealed in an envelope with the classroom identification form and returned to PPRI.

Survey Administration for the Original Study

The survey was available in either scannable paper/pencil format or online administration using Lime Survey software.

Data Entry for the Original Study

In the original study, immediately after administration of the questionnaires, all the survey instruments were returned to PPRI for scanning and coding using an optical scanner. PPRI also recorded all the data using statistical software that can analyze the data and generate tables. The survey instrument did not include personal identifiers. To further increase confidentiality of the participants, groups with less than 10 respondents were removed from analysis in order to eliminate the chance of students in such small groups being easily identified. The age of students was used to assign any missing grade information to the expected age-based grade level (PPRI, 2018).

Quality Control Measures in the Original Study

To ensure the quality of the survey, PPRI conducted several internal quality control checks which guided the survey. A quality control analyst oversaw the analysis and quality control process. The responsibilities of the quality control analyst included monitoring and tracking each school district's survey and ensuring that all surveys were properly coded and scanned, and that abnormalities were avoided. There were also procedural quality control checks implemented. Each survey instrument was coded with a five-digit litho-code scannable number when printed in order to ensure that if it were

placed out of order when scanned, the correct survey would be recorded in the correct record. Furthermore, a physical audit check was done on 10% of the surveys to clarify that the number manually counted corresponded to the scanner automated count.

Reliability and Validity of the Survey Instrument

The survey instrument (questionnaire) used for data collection in the original study is considered reliable and valid. The original Youth Tobacco Survey was developed using the CDC's Youth Risk Behavior Survey (YRBS) and the NYTS (PPRI, 2018). State and local agencies can modify the questionnaire to fit their intended needs (PPRI, 2018). Though all survey instruments are considered reliable and valid, it should be noted that the instruments cannot be guaranteed with 100% certainty.

Credibility of collected data can vary by participant's responses. For responses to be considered truthful, participants must also perceive the study as important and understand how their privacy will be protected (CDC, 2018b; PPRI, 2018).

Threats to Validity

External Validity

There are several threats to external validity in the original study. The questionnaire was self-administered, and respondents may not have provided accurate, honest answers. Schools targeted for participation who declined might have threatened the validity of the study as non-participation of targeted schools may limit the generalizability of the finding to the general population. There is also the possibility of

social desirability bias where respondents who chose to participate may feel the need to provide socially acceptable responses. These concerns can be minimized by reassuring respondents that no personal information such as respondent's name, school, school district, city, or county will be identified in reports based on the results.

Construct Validity

In the original study, the questionnaire was modeled after the CDC's NYTS, thus, it is considered reliable and valid because it accurately measures what it is intended to measure.

Methodology for Secondary Data Analysis

A total of 15,096 students in grades 6 through 12, aged 11 to 18, completed the survey. This study is a secondary data analysis, and the entire sample of 15,096 available for the study were used for the data analysis. Unlike the original data collection which employed probability proportionate to size sampling, this secondary data analysis will utilize convenience sampling, a nonprobability sampling design (Creswell, 2014).

Description of Variables

The purpose of this study was to examine the magnitude of association between the predictor variables age, gender, grade level, ethnicity, and race and the dependent variable e-cigarette use among adolescents in Texas using a quantitative approach to analyze secondary data from the TYTS.

Independent Variables. The independent variables were ethnicity, race, gender, age, and grade level.

Dependent Variables. The dependent variable is e-cigarette use.

Covariates. The covariates for this study are area of residence and socioeconomic status.

Race. This is a categorical nominal variable. Students were asked to select from one of the following categories: American Indian or Alaska Native; Native Hawaiian or other Pacific Islander; Asian; White; Black or African American; or more than one race.

Ethnicity. Ethnicity is separated from race in the questionnaire, but it is also a categorical nominal variable. To assess ethnicity, the students were generally asked if they are Hispanic or Latino and asked to select responses from three options of: 1) No; or 2) Yes - Mexican, Mexican American, or Chicano; or 3) Yes - other Hispanic or Latino not listed.

Gender. Gender is categorical dichotomous variable with options of male or female.

Age. Age is a continuous (quantitative) variable. Participants can put their exact age or round it to a whole number.

Grade Level. This is a categorical ordinal variable in ranked order with possible responses of grade 6, 7, 8, 9, 10, 11 or 12.

Area of Residence (AOR). The area of residence of the participants will be determined from either the coalition area sample or the state sample. This parameter is employed because coalitions areas are funded to provide on-going tobacco prevention and control efforts in the state, thereby serving as a base with which to compare with the state

schools. The coalition areas are also sampled with a different approach from the state schools. This survey includes nine coalition areas comprising 80 school districts, with the other areas comprising the state schools. The AOR for this study is considered a categorical dichotomous variable.

Socioeconomic Status (SES). SES for this study is considered a dichotomous variable in which the student's SES is assessed based on eligibility for free or reduced-price school lunch.

Instrumentation and Operationalization of Constructs

The survey instrument was a questionnaire. The 2018 TYTS consist of an eight-page, 39- item questionnaire developed by Texas DSHS and PPRI for students in grades 6 to 12 to inform state and local level policy makers about the level of tobacco use by adolescents in Texas. The questionnaire received approval from the University of Texas Tobacco Prevention and Cessation Coalition (TPCC) evaluation team, Texas DSHS and Texas A&M University IRB. For this secondary data analysis, I applied to Walden University IRB for approval prior to conducting the data analysis.

Following a written request to both the TDSHS and PPRI, the de-identified data from this survey were released to me. I analyzed the data using the Statistical Package for Social Sciences (SPSS). During the original data collection process, a sample size weighting was implemented to ensure that participant selection into the survey would adequately represent the population of adolescents in Texas.

Data Collection

Secondary data from Texas YTS conducted by the Texas Department of State Health Services were used for this study. Permission for this study to be conducted was granted by The Institutional Review Board at Walden University with the approval number: 09-14-20-0508473.

All available data for the 2018 Texas YTS originally collected by the Public Policy Research Institute (PPRI) of Texas A&M University were provided to me as a de-identified dataset. The data were weighted by the primary investigators to ensure that the participants' responses adequately represented the adolescent population in the state of Texas. To protect the participants' identity and prevent possible identification of any participants, the primary investigators removed any groups with less than 10 participant responses from the dataset. The dataset received contained all data for the dependent variable (e-cigarette use), independent variables (age, gender, grade level and ethnicity), and the covariates (socioeconomic status and area of residence). The 2018 Texas YTS consisted of a representative sample of middle and high school students. A total of 15,096 students participated in the survey.

Data Cleaning and Recoding

Several steps were taken to prepare the secondary dataset for analysis. First, the dataset was received from the TDSHS as an excel file and it was converted into an SPSS file. Next, since the dataset consisted of numerous variables, only the variables of interest

which were required to answer the research questions for this study were transferred into another file, creating a new file. This file became the working dataset. For clarity, additional steps were taken to accurately label the dataset with the appropriate variable names used for this study and the values coded with the appropriate codes assigned during the original data collection.

For analysis purpose, some variables were recoded to make them more appropriate for analysis. Furthermore, to maintain uniformity in sample size for all analysis, the missing/ nonresponse data for all cases were replaced using the SPSS function of "replacing with the median of all nearby points". Replacing with the median of nearby points (rather than the mean) was more appropriate for use with non-parametric tests (Wagner, 2017); thus, it was used for the missing data replacement in this research.

Data recoding was conducted for e-cigarette use, ethnicity, race, and socioeconomic status to make them appropriate for analysis. Data recoding was conducted for e-cigarette use, ethnicity, race, and socioeconomic status to make them appropriate for analysis. The dependent variable e-cigarette use was assessed based on self-report of e-cigarette use or non-use using the TYTS question 14d: "Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?" There were however, three responses: "No", "Yes", and "No, Never Heard of it". For analysis purpose, the dependent variable needed to be dichotomized as either "yes" or "no". I therefore recoded

the variable using the SPSS function for transforming variables by recoding the two different classifications with “No” and “No, Never Heard of it” responses to create a single “No” response. Thus, in analyzing for the dependent variable e-cigarette use, a dichotomous response of “No” and “Yes” were generated for BLR.

The independent variable ethnicity was assessed by using the TYTS Question 4: Are you Hispanic or Latino?, with three response option, one option for non-Hispanic and the other two options for two different Hispanic classifications (“Yes, Mexican, Mexican America or Chicano” and “Yes, some other Hispanic or Latino not listed”). For analysis purpose, these two different classifications of Hispanic were recoded using the SPSS function for transforming variables by recoding the two classifications of Hispanic (from the original coding) to create a new variable for being Hispanic with the name (“Yes, I am Hispanic”). Thus, in analyzing for ethnicity using the recoded variable, the response will either be classified as being non-Hispanic (No, I am not Hispanic) or as being Hispanic (Yes, I am Hispanic).

The independent variable race was assessed by using the TYTS Question 4a: What race do you consider yourself to be?, with five nominal variable responses. In order to conduct BLR using SPSS, categorical variables need to be defined with the reference category coded as either the first or last. For this study, “White” is the reference category, however, in the original coding, “White” was not coded as the first or last, which is required for SPSS analysis. Using the SPSS function for transforming variables, I

therefore recoded the race in order to place the reference category (White)" as the first or last response option, as required for BLR in SPSS.

The covariate SES, the variable was assessed based on eligibility for free or reduced-price school lunch using the TYTS question 6: during the current school year, do you qualify for a free or reduced-price school lunch?. Qualifying for free or reduced-price school lunch is considered an indication of low SES. There were however, three response options with one option as a neutral response (Don't know). For analysis purpose, a response needed to be classified as qualifying or not qualifying for school lunch. I therefore recoded the variable using the SPSS function for "replacing with the median of all nearby points". Thus, neutral responses (Don't know) were replaced by SPSS to be either qualified or not qualified for school lunch.

Data Analysis Plan

The goal of this study was to provide an understanding of the influences, if any, of sociodemographic variables on e-cigarette use among Texas youth. The data analysis utilized both descriptive and inferential statistics.

Research Questions and Hypothesis

RQ1: Is there an association between age and e-cigarette use among Texas adolescents?

$H_0$1: There is no association between age and e-cigarette use among Texas adolescents.

H_a1: There is an association between age and e-cigarette use among Texas adolescents.

RQ2: Is there an association between gender and e-cigarette use among Texas adolescents?

H_02: There is no association between gender and e-cigarette use among Texas adolescents.

H_a2: There is an association between gender and e-cigarette use among Texas adolescents.

RQ3: Is there an association between grade level and e-cigarette use among Texas adolescents?

H_03: There is no association between grade level and e-cigarette use among Texas adolescents.

H_a3: There is an association between grade level and e-cigarette use among Texas adolescents.

RQ4: Is there an association between ethnicity and e-cigarette use among Texas adolescents?

H_04: There is no association between ethnicity and e-cigarette use among Texas adolescents.

H_a4: There is an association between ethnicity and e-cigarette use among Texas adolescents.

RQ5: Is there an association between race and e-cigarette use among Texas adolescents?

$H_0$5: There is no association between race and e-cigarette use among Texas adolescents.

H_a5: There is an association between race and e-cigarette use among Texas adolescents.

Descriptive statistics were used to provide a description of the data used. Two measures of central tendency - mean and median (in particular, median), were used to describe the prevalences of the variables studied. The information was presented in visual forms using tables.

To provide an inferential conclusion about the population of Texas youth from the sample of participants in the survey, statistical analyses using logistic regression were done to delineate strengths of relationships and measures of association. I used Pearson's Chi-Square and binary logistic regression analyses to explain the association between the independent variables and the dependent variable under study. Pearson's Chi-Square is the appropriate statistical test to examine relationships between categorical dependent variables and independent variables from unpaired samples such as in cross-sectional studies as used for the Youth Tobacco Survey (Nayak & Hazra, 2011). Using binomial logistic regression analysis helped me to further determine which predictor (independent) variables and covariates, influence the use of e-cigarettes by the study population. The

secondary data were analyzed using SPSS statistical software (vs. 25) to determine e-cigarette use and its relationship to the sociodemographic characteristics of the study population.

Inferential Analysis

RQ1: Is there an association between age and e-cigarette use among Texas adolescents?

The independent variable age was assessed by using the TYTS Question 1: How old are you?

The dependent variable e-cigarette use was assessed by using the TYTS Question 14d: Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?

RQ2: Is there an association between gender and e-cigarette use among Texas adolescents?

The independent variable gender was assessed by using the TYTS Question 2: Are you Female or Male?

The dependent variable e-cigarette use was assessed by using the TYTS Question 14d: Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?

RQ3: Is there an association between grade level and e-cigarette use among Texas adolescents?

The independent variable grade level was assessed by using the TYTS Question 3: What grade are you in?

The dependent variable e-cigarette use was assessed by using the TYTS Question 14d: Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?

RQ4: Is there an association between ethnicity and e-cigarette use among Texas adolescents?

The independent variable ethnicity was assessed by using the TYTS Question 4: Are you Hispanic or Latino?

The dependent variable e-cigarette use was assessed by using the TYTS Question 14d: Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?

RQ5: Is there an association between race and e-cigarette use among Texas adolescents?

The independent variable race was assessed by using the TYTS Question 4a: What race do you consider yourself to be?

The dependent variable e-cigarette use was assessed by using the TYTS Question 14d: Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?

To examine the effects of the covariates (SES and AOR) on the association between the dependent variable and each of the independent variables, additional questions were analyzed using multivariate logistic regression.

The covariate SES was assessed by using the TYTS Question 6: During the current school year, do you qualify for free or reduced-price school lunch?

The covariate AOR was assessed by stratification of the results based on where the survey data were collected, either from state schools or from coalition areas.

Assumptions of Logistic Regression

Logistic regression has certain assumptions, which need to be met in order to obtain valid results. For binary logistic regression, the dependent variable should be binary, measured on a dichotomous scale. In this secondary data analysis, the dependent variable e-cigarette was measured on a dichotomous scale of either use or non-use (yes or no). Another assumption of logistic regression is that there will be one or more independent variables which can be either continuous or categorical. In this study, the independent variable age is a continuous variable, while the independent variable gender is a dichotomous (categorical) variable, the independent variable grade level is an ordinal (categorical) variable, and the independent variable race is a nominal (categorical) variable.

In logistic regression, the independent variables should not be highly correlated with each other. In this study, the independent variables, age, race, gender and grade, are

not highly correlated. Another assumption is that the observations should be independent, In the original survey, all the data were independently collected from each participant, as there were no repeated measurements or matched data from the participants. Therefore, this secondary data analysis will be using independently recorded observations, which meets the assumption.

Furthermore, logistic regression does not require linear relationships between the dependent and independent variables, but it assumes that a linear relationship exists between continuous independent variables and the logit transformation of the dependent variable. Logistic regression also requires a large sample size. A total of 15,096 students participated in the primary survey and the entire sample was used for this secondary data analysis.

Sample Size

G* Power 3.1.9.7 (Faul, Erdfelder, Buchner, & Lang, 2009) was used to determine the statistical power necessary to prevent a Type II error. We want to be able to detect an effect of the independent variables on the dependent variable when truly there is an effect and avoid failing to reject the null hypothesis (false negative, Type II error). To determine the power, I used the whole sample approach, utilizing the entire response sample of 15,096 students. However, I ran the G*Power analysis to determine the statistical power and small effect size that would be needed to prevent the Type II error, that is, to avoid failing to reject the null hypothesis when there is an effect. The

entire sample of 15,096 students was sufficient to achieve a small effect size of 0.02 and a statistical power of 98%. SPSS was used to perform all data analyses.

Ethical Protection of Human Participants

During the original study, adequate measures were taken to protect the individuals who voluntarily accepted to participate in this study. Each selected school was required to complete a written participation consent form, while parental or legal guardian written consent was requested for the selected classrooms.

The protocols were approved by the University of Texas TPCC evaluation team and DSHS. DSHS' Institutional Review Board (IRB) was responsible for ensuring all research conducted by the State employees or representatives met ethical guidelines and United States federal regulations (PPRI, 2018). Completion of the study did not result in harm to any participants. Participation was optional, and participants could withdraw at any time, even after parental consent was provided. Only individuals whose gave informed consent participated.

This study was a secondary analysis of a community partnered dataset collected by the Texas DSHS and the PPRI of the University of Texas A&M. Though the dataset was collected by DSHS, a State government agency, it was not made publicly available. I was required to ask permission to use the dataset, and I emailed Texas DSHS and PPRI to receive a copy of the data. I applied to the Walden University IRB and obtained approval to conduct this study.

Summary

This chapter has described the study research design, instrumentation, and methodology for the original study / primary data collection and the secondary data analysis. The study examined the influence of sociodemographic characteristics of the participants (independent variables) on e-cigarette use (dependent variable) of adolescents in Texas, by conducting secondary data analysis of the 2018 TYTS. In the original study, the data were collected using a stratified, two-stage proportionate to size sample design to produce a state-wide representative sample of public middle school and high school students in Texas. Schools were recruited for the survey in the Spring of 2018, and a total of 15,096 student questionnaires were completed and returned, with voluntary participation. For this secondary data analysis, I utilized the entire sample from the original survey and binary logistic regression analysis conducted with SPSS.

Chapter 4: Results

Introduction

The use of electronic cigarettes has been increasing among the youth, replacing the use of conventional cigarettes (CDC, 2018a; Perikleous et al., 2018). The FDA (2018a) reported e-cigarette use by the youth as becoming an epidemic engulfing the youth. Reports further indicated that e-cigarettes have been the most common tobacco product used by adolescents in the United States since 2014 (CDC, 2018a; Wang et al., 2018). Texas is a highly diverse state with some racial and ethnic groups outnumbering other groups (Texas Department of State Health Services (TDSHS), 2019). Sociodemographic factors have been recognized as major contributors to illicit behaviors among adolescents (Whitesell, Bachand, Peel, & Brown, 2013). It was, therefore, the aim of this study to examine sociodemographic factors, including age, gender, grade level, and race, that are associated with e-cigarette use among adolescents in Texas.

Five research questions were formulated for this study, and they were addressed through the statistical analyses of secondary data from the 2018 Texas YTS. The following research questions and hypotheses were constructed for this study.

RQ1: Is there an association between age and e-cigarette use among Texas adolescents?

$H_0$1: There is no association between age and e-cigarette use among Texas adolescents.

H_a1: There is an association between age and e-cigarette use among Texas adolescents.

RQ2: Is there an association between gender and e-cigarette use among Texas adolescents?

H_02: There is no association between gender and e-cigarette use among Texas adolescents.

H_a2: There is an association between gender and e-cigarette use among Texas adolescents.

RQ3: Is there an association between grade level and e-cigarette use among Texas adolescents?

H_03: There is no association between grade level and e-cigarette use among Texas adolescents.

H_a3: There is an association between grade level and e-cigarette use among Texas adolescents.

RQ4: Is there an association between ethnicity and e-cigarette use among Texas adolescents?

H_04: There is no association between ethnicity and e-cigarette use among Texas adolescents.

H_a4: There is an association between ethnicity and e-cigarette use among Texas adolescents.

RQ5: Is there an association between race and e-cigarette use among Texas adolescents?

$H_0$5: There is no association between race and e-cigarette use among Texas adolescents.

H_a5: There is an association between race and e-cigarette use among Texas adolescents.

This chapter discusses analysis of the secondary data.

Data Analysis

Analysis of the secondary data set from the Texas YTS was conducted with SPSS vs. 25. The entire sample size was used for the analysis. For preliminary data analysis, descriptive statistics were calculated to obtain background information about the participants. The participants' age ranged from 11 to 18 years with a mean age of 14 years (Table 1a). Approximately 50.8 percent of the participants were men, while 49.2 percent were women.

The descriptive statistics of participants are presented below. For inferential analysis, the variables required to answer each of the research questions were coded, while recoding was further done to re-categorize some demographic characteristics for appropriate analysis. The recoding of pertinent variables was described in Chapter 3.

Table 1a

Descriptive Statistics: Demographic Characteristics of the Study Participants (N=15,096)

Characteristics	Frequency	Percent
E-cigarette use		
No	12014	79.6
Yes	3082	20.4
Total	15096	100.0
Age		
11 years old or younger	880	5.8
12 years old	2487	16.5
13 years old	2919	19.3
14 years old	2364	15.7
15 years old	1952	12.9
16 years old	1756	11.6
17 years old	1691	11.2
18 years old	1047	6.9
Total	15096	100.0
Gender		
Men	7664	50.8
Women	7432	49.2
Total	15096	100.0
Grade level		
6th grade	2582	17.1
7th grade	2991	19.8
8th grade	2740	18.2
9th grade	1954	12.9
10th grade	1740	11.5
11th grade	1703	11.3
12th grade	1386	9.2
Total	15096	100.0
Ethnicity		
No, I am not Hispanic	9047	59.9
Yes, I am Mexican American or Chicano	4534	30.0
Yes, I am some other Hispanic or	1515	10.0

Latino not listed here		
Total	15096	100.0
Race		
American Indian or Alaskan Native	657	4.4
Asian	281	1.9
Black or African American	1324	8.8
Native Hawaiian or other Pacific Islander	97	0.6
White	9113	60.4
More than one race	3624	24.0
Total	15096	100.0
Socioeconomic status		
No, not qualified for free/reduced lunch	4755	31.5
Yes, qualified for free/reduced lunch	6311	41.8
Don't know	4030	26.7
Total	15096	100.0
Area of residence (AOR; Based on coalition area or non-coalition area)		
Coalition area	8576	56.8
Non-coalition area	6520	43.2
Total	15096	100.0

Table 1b

Descriptive Statistics for the Dependent Variable E-Cigarette

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	7664	50.8	71.3	71.3
	Yes	3082	20.4	28.7	100.0
	Total	10746	71.2	100.0	
Missing	No, Never Heard of It	3819	25.3		
	System	531	3.5		
	Total	4350	28.8		
Total		15096	100.0		

Table 1c

Descriptive Statistics for the Dependent Variable E-Cigarette Recoded

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	12014	79.6	79.6	79.6
	Yes	3082	20.4	20.4	100.0
	Total	15096	100.0	100.0	

Inferential Statistics using Pearson Chi-Square test and Binary Logistic Regression were undertaken to answer each of the research questions for examining possible association between the categorical dependent variable (e-cigarette use) and the independent variables. Binary Logistic Regression is based on a dichotomous event. The dependent variable (e-cigarette use) was prepared for binary logistic regression analysis

using the survey question 14d: “Have you ever tried using electronic cigarettes, also called e-cigarettes, vape pens, e-hookah, hookah pens, and e-cigarettes such as NJOY, Blu, or Logic?” Participants who responded with “No, never heard of it” were recoded as missing data and were treated as missing following the process earlier discussed in data cleaning process (Table 1c).

The results from the cross-tabulation Chi-Square analyses are shown in Tables 2 to 8, while the results from Binary Logistic Regression are depicted in Tables 9 to 13.

Testing Bivariate Relationships

RQ1: Is there an association between age and e-cigarette use among Texas adolescents? The independent variable age was assessed by using the TYTS Question 1: How old are you? The dependent variable e-cigarette use was assessed by using the TYTS Question 14d, as earlier stated. From Table 2, the number of adolescents using e-cigarettes (“yes” response) increased as the participants’ age increased, ranging from 4.8% at age 11 to 42.1% at age 18. The findings showed a statistically significant relationship between age and adolescent e-cigarette use ($P<0.01$).

Table 2a

Results of the Relationship (Crosstabulation) Between Age and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
AGE	11 Years old or Younger	Count	838	42	880
		% within AGE	95.2%	4.8%	100.0%
	12 Years old	Count	2337	150	2487
		% within AGE	94.0%	6.0%	100.0%
	13 Years old	Count	2559	360	2919
		% within AGE	87.7%	12.3%	100.0%
	14 Years old	Count	1936	428	2364
		% within AGE	81.9%	18.1%	100.0%
	15 Years old	Count	1421	531	1952
		% within AGE	72.8%	27.2%	100.0%
	16 Years old	Count	1238	518	1756
		% within AGE	70.5%	29.5%	100.0%
	17 Years old	Count	1079	612	1691
		% within AGE	63.8%	36.2%	100.0%
	18 Years old or Older	Count	606	441	1047
		% within AGE	57.9%	42.1%	100.0%
Total		Count	12014	3082	15096
		% within AGE	79.6%	20.4%	100.0%

Table 2b

Chi-Square Tests of the Relationship Between Age and E-Cigarette Use

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1281.477[a]	7	.000
Likelihood Ratio	1339.107	7	.000
Linear-by-Linear Association	1262.629	1	.000
N of Valid Cases	15096		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 179.66.

RQ2: Is there an association between gender and e-cigarette use among Texas adolescents? The independent variable gender was assessed by using the TYTS Question 2: Are you Female or Male? The dependent variable e-cigarette use was assessed by using the TYTS Question 14d. From the test of bivariate relationship between e-cigarette use and gender (Table 3a), 21.0% of men and 19.8% of women responded yes to e-cigarette use. There was no statistically significant relationship between gender and e-cigarette use ($P>0.05$).

Table 3a

Results of the Relationship (Crosstabulation) Between Gender and E-Cigarette Use

*GENDER * E-CIGARETTE USE Crosstabulation*

			E-CIGARETTE USE		
			No	Yes	Total
GENDER	Male	Count	6052	1612	7664
		% within GENDER	79.0%	21.0%	100.0%
	Female	Count	5962	1470	7432
		% within GENDER	80.2%	19.8%	100.0%
Total		Count	12014	3082	15096
		% within GENDER	79.6%	20.4%	100.0%

Table 3b

Chi-Square Tests of the Relationship Between Gender and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.652[a]	1	.056		
Continuity Correction[b]	3.575	1	.059		
Likelihood Ratio	3.653	1	.056		
Fisher's Exact Test				.058	.029
Linear-by-Linear Association	3.652	1	.056		
N of Valid Cases	15096				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 1517.32.

b. Computed only for a 2x2 table

RQ3: Is there an association between grade level and e-cigarette use among Texas adolescents? The independent variable grade level was assessed by using the TYTS Question 3: What grade are you in? The dependent variable e-cigarette use was assessed by using the TYTS Question 14d. From Table 4a, the number of adolescents using e-cigarettes ("yes" response) increased as the participants' grade level increased from 5.8% for grade 6 to 43.0% for grade 12, and $P<0.01$, indicating a statistically significant relationship between grade level and adolescent e-cigarette use.

Table 4a

Results of the Relationship (Crosstabulation) Between Grade Level and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
GRADE LEVEL	6th grade	Count	2432	150	2582
		% within GRADE LEVEL	94.2%	5.8%	100.0%
	7th grade	Count	2676	315	2991
		% within GRADE LEVEL	89.5%	10.5%	100.0%
	8th grade	Count	2290	450	2740
		% within GRADE LEVEL	83.6%	16.4%	100.0%
	9th grade	Count	1449	505	1954
		% within GRADE LEVEL	74.2%	25.8%	100.0%
	10th grade	Count	1235	505	1740
		% within GRADE LEVEL	71.0%	29.0%	100.0%
	11th grade	Count	1142	561	1703
		% within GRADE LEVEL	67.1%	32.9%	100.0%
	12th grade	Count	790	596	1386
		% within GRADE LEVEL	57.0%	43.0%	100.0%
Total		Count	12014	3082	15096
		% within GRADE LEVEL	79.6%	20.4%	100.0%

Table 4b

Chi-Square Tests of the Relationship Between Grade Level and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1260.137[a]	6	.000
Likelihood Ratio	1292.641	6	.000
Linear-by-Linear Association	1241.126	1	.000
N of Valid Cases	15096		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 282.97.

RQ4: Is there an association between ethnicity and e-cigarette use among Texas adolescents? The independent variable ethnicity was assessed by using the TYTS Question 4: Are you Hispanic or Latino? The dependent variable e-cigarette use was assessed by using the TYTS Question 14d. From Tables 5a and 5b, the participants from the two different Hispanic classifications ("Yes, Mexican, Mexican America or Chicano" and "Yes, some other Hispanic or Latino not listed") were analyzed based on the original data coding, as well as recoded data (Tables 5c and 5d) to combine all Hispanic individuals under one category ("Yes, I am Hispanic"); statistical significance was noted ($P<0.01$) indicating a relationship between being non-Hispanic and adolescent e-cigarette use.

Table 5a

Results of the Relationship (Crosstabulation) Between Ethnicity and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
ETHNICITY	No	Count	7048	1999	9047
		% within ETHNICITY	77.9%	22.1%	100.0%
	Yes, I am Mexican, Mexican American or Chicano	Count	3729	805	4534
		% within ETHNICITY	82.2%	17.8%	100.0%
	Yes, I am some other Hispanic or Latino not listed here	Count	1237	278	1515
		% within ETHNICITY	81.7%	18.3%	100.0%
Total		Count	12014	3082	15096
		% within ETHNICITY	79.6%	20.4%	100.0%

Table 5b

Chi-Square Tests of the Relationship Between Ethnicity and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.454[a]	2	.000
Likelihood Ratio	39.941	2	.000
Linear-by-Linear Association	30.379	1	.000
N of Valid Cases	15096		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 309.30.

Table 5c

Results of the Relationship (Crosstabulation) Between Ethnicity Recoded and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
ETHNICITY RECODED	No, I am not Hispanic	Count	7048	1999	9047
		% within ETHNICITY RECODED	77.9%	22.1%	100.0%
	Yes, I am Hispanic	Count	4966	1083	6049
		% within ETHNICITY RECODED	82.1%	17.9%	100.0%
Total		Count	12014	3082	15096
		% within ETHNICITY RECODED	79.6%	20.4%	100.0%

Table 5d

Chi-Square Tests of the Relationship Between Ethnicity Recoded and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	39.207[a]	1	.000		
Continuity Correction[b]	38.949	1	.000		
Likelihood Ratio	39.668	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	39.204	1	.000		
N of Valid Cases	15096				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 1234.96.

b. Computed only for a 2x2 table

RQ5: Is there an association between race and e-cigarette use among Texas adolescents? The independent variable race was assessed by using the TYTS Question 4a: What race do you consider yourself to be? The dependent variable e-cigarette use was assessed by using the TYTS Question 14d. From Table 6, the number of adolescents using e-cigarette ("yes" response) was highest among the White race (N= 2044; 22.4%) in comparison with other races, and the association was statistically significant ($P<0.01$) (Table 6b).

Table 6a

Results of the Relationship (Crosstabulation) Between Race Recoded and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
RACE RECODED	White	Count	7069	2044	9113
		% within RACE RECODED	77.6%	22.4%	100.0%
	American Indian or Alaska Native	Count	532	125	657
		% within RACE RECODED	81.0%	19.0%	100.0%
	Asian	Count	250	31	281
		% within RACE RECODED	89.0%	11.0%	100.0%
	Black or African American	Count	1128	196	1324
		% within RACE RECODED	85.2%	14.8%	100.0%
	Native Hawaiian or Other Pacific Islander	Count	77	20	97
		% within RACE RECODED	79.4%	20.6%	100.0%
	More Than One Race	Count	2958	666	3624
		% within RACE RECODED	81.6%	18.4%	100.0%
Total		Count	12014	3082	15096
		% within RACE RECODED	79.6%	20.4%	100.0%

Table 6b

Chi-Square Tests of the Relationship Between Race Recoded and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	73.688[a]	5	.000
Likelihood Ratio	77.820	5	.000
Linear-by-Linear Association	38.275	1	.000
N of Valid Cases	15096		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 19.80.

The bivariate relationships between e-cigarette use and the covariates SES and AOR were also analyzed. SES was assessed based on eligibility for free or reduced-price school lunch using question 6, "during the current school year, do you qualify for a free or reduced-price school lunch?" Qualifying for free or reduced-price school lunch is considered an indication of low SES. From the analysis (Table 7), a higher percentage of adolescents considered as high SES (23.8%) responded "yes" to e-cigarette use than adolescents with low SES (22.0%), and the relationship between SES and e-cigarette use was statistically significant ($P< 0.05$).

Table 7a

Results of the Relationship (Crosstabulation) Between SES and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
SOCIOECONOMIC STATUS	No, not qualified for free/reduced lunch	Count	3625	1130	4755
		% within SOCIOECONOMIC STATUS	76.2%	23.8%	100.0%
	Yes, qualified for free/reduced lunch	Count	4922	1389	6311
		% within SOCIOECONOMIC STATUS	78.0%	22.0%	100.0%
	Don't know	Count	3467	563	4030
		% within SOCIOECONOMIC STATUS	86.0%	14.0%	100.0%
Total		Count	12014	3082	15096
		% within SOCIOECONOMIC STATUS	79.6%	20.4%	100.0%

Table 7b

Chi-Square Tests of the Relationship Between SES and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	145.725[a]	2	.000
Likelihood Ratio	154.093	2	.000

Linear-by-Linear Association	123.467	1	.000
N of Valid Cases	15096		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 822.76.

Table 7c

Results of the Relationship (Crosstabulation) Between SES Recoded and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
SOCIOECONOMIC STATUS RECODED	No, not qualified for free/reduced lunch	Count	3625	1130	4755
		% within SOCIOECONOMIC STATUS RECODED	76.2%	23.8%	100.0%
	Yes, qualified for free/reduced lunch	Count	8389	1952	10341
		% within SOCIOECONOMIC STATUS RECODED	81.1%	18.9%	100.0%
Total		Count	12014	3082	15096
		% within SOCIOECONOMIC STATUS RECODED	79.6%	20.4%	100.0%

Table 7d

Chi-Square Tests of the Relationship Between SES Recoded and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	47.901[a]	1	.000		
Continuity Correction[b]	47.600	1	.000		
Likelihood Ratio	46.970	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	47.898	1	.000		
N of Valid Cases	15096				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 970.78.

b. Computed only for a 2x2 table

The AOR for this study was determined based on whether the sample was collected from coalition areas or from non-coalition areas. From the test of bivariate relationship between e-cigarette use and AOR (Table 8), adolescents residing in the coalition area (21.1%) are more likely to use e-cigarettes than adolescents residing in non-coalition areas (19.5%), and there was statistically significant relationship between AOR and e-cigarette use ($P<0.05$).

Table 8a

Results of the Relationship (Crosstabulation) Between Area of Residence and E-Cigarette Use

			E-CIGARETTE USE		
			No	Yes	Total
AREA OF RESIDENCE	Coalition Area	Count	6764	1812	8576
		% within AREA OF RESIDENCE	78.9%	21.1%	100.0%
	Non-Coalition Area	Count	5250	1270	6520
		% within AREA OF RESIDENCE	80.5%	19.5%	100.0%
Total		Count	12014	3082	15096
		% within AREA OF RESIDENCE	79.6%	20.4%	100.0%

Table 8b

Chi-Square Tests of the Relationship Between Area of Residence and E-Cigarette Use

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.208[a]	1	.013		
Continuity Correction[b]	6.107	1	.013		
Likelihood Ratio	6.226	1	.013		
Fisher's Exact Test				.013	.007
Linear-by-Linear Association	6.208	1	.013		
N of Valid Cases	15096				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 1331.12.

b. Computed only for a 2x2 table

Findings from the bivariate analyses revealed significant associations between the dependent variable e-cigarette use and some independent variables (age, grade level, ethnicity, race, SES, and AOR), while only a slight relationship (P=0.056) was found for gender.

BLR was further conducted to estimate the probability of an event (outcome variable) based on a change in each predictor variable, while controlling for the other variables in the model. To conduct a logistic regression analysis, all the independent categorical variables were coded, using a value of 0 for the reference category. BLR was conducted for this study to examine the magnitude of relationship between the outcome variable (e-cigarette use) and the predictor variables, age, gender, grade level, ethnicity, and race, as well as the effects of the covariates, SES and AOR in these relationships. To hold each variable constant while controlling for the effect of the other variables, all the variables and covariates were included in the regression model. The case processing summary (Table 9) shows the total number of cases included in the analysis.

Table 9

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	15096	100.0
	Missing Cases	0	.0
	Total	15096	100.0
Unselected Cases		0	.0
Total		15096	100.0

a. If weight is in effect, see classification table for the total number of cases.

Table 10

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	13830.792[a]	.092	.144

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Table 11

Classification Table

a

			Predicted		
			E-CIGARETTE USE		Percentage Correct
	Observed		No	Yes	
Step 1	E-CIGARETTE USE	No	12008	6	100.0
		Yes	3071	11	.4
	Overall Percentage				79.6

a. The cut value is .500

Table 12

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	11.391	8	.181

Table 13

Variables in the Equation

							95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	AGE			69.301	7	.000			
	AGE(1)	.198	.187	1.123	1	.289	1.219	.845	1.758
	AGE(2)	.858	.210	16.762	1	.000	2.359	1.564	3.557
	AGE(3)	1.184	.225	27.814	1	.000	3.269	2.105	5.077
	AGE(4)	1.537	.238	41.673	1	.000	4.648	2.915	7.412
	AGE(5)	1.565	.250	39.184	1	.000	4.785	2.931	7.812
	AGE(6)	1.710	.261	43.014	1	.000	5.526	3.316	9.211
	AGE(7)	1.716	.274	39.225	1	.000	5.561	3.250	9.513
	GENDER(1)	-.081	.043	3.628	1	.057	.922	.848	1.002
	GRADE LEVEL			28.830	6	.000			
	GRADE LEVEL(1)	.128	.137	.866	1	.352	1.136	.868	1.487
	GRADE LEVEL(2)	.249	.160	2.424	1	.119	1.283	.938	1.754
	GRADE LEVEL(3)	.479	.181	7.028	1	.008	1.615	1.133	2.302
	GRADE LEVEL(4)	.529	.196	7.254	1	.007	1.697	1.155	2.493
	GRADE LEVEL(5)	.612	.211	8.430	1	.004	1.844	1.220	2.787
	GRADE LEVEL(6)	1.001	.225	19.783	1	.000	2.721	1.751	4.231
	ETHNICITY RECODED(1)	-.242	.051	22.924	1	.000	.785	.711	.867
	RACE RECODED			53.227	5	.000			
	RACE RECODED(1)	.158	.110	2.061	1	.151	1.171	.944	1.453
	RACE RECODED(2)	-.654	.199	10.861	1	.001	.520	.352	.767
	RACE RECODED(3)	-.511	.086	35.459	1	.000	.600	.507	.710
	RACE RECODED(4)	.108	.267	.162	1	.687	1.114	.660	1.880
	RACE RECODED(5)	.094	.057	2.706	1	.100	1.099	.982	1.229
	SOCIOECONOMIC STATUS RECODED (1)	-.071	.047	2.288	1	.130	.931	.850	1.021
	AREA OF RESIDENCE(1)	.022	.044	.252	1	.616	1.022	.938	1.113
	Constant	-2.798	.165	287.569	1	.000	.061		

a. Variable(s) entered on step 1: AGE, GENDER, GRADE LEVEL, ETHNICITY RECODED, RACE RECODED, SOCIOECONOMIC STATUS RECODED, AREA OF RESIDENCE.

Summary of Tables 10-13

A BLR analyses was conducted to investigate whether age, gender, grade level, ethnicity, race, socioeconomic status, and area of residence predict the probability of e-cigarette use by adolescents in Texas. As shown in Table 9 (case processing summary), the entire sample (*N*= 15,096; 100 percent) was included in the analyses. The Hosmer-Lemeshow goodness-of-fit (Table 12) was not significant (P>0.05), indicating that the model fits well and is correctly specified. Furthermore, the Nagelkerke R Squared = .144 (Table 10), indicating that the model explained about 14.4% of the variance in e-cigarette use.

In Table 13, it is seen that the independent variables age, grade level, ethnicity, and race were significant predictors of e-cigarette use among Texas adolescents (P<0.05), while the independent variable gender and the covariates SES and AOR were found to be not significant (P>0.05). Controlling for all the other variables, the predictor variable age was noted to contribute greatly to odds of e-cigarette use. At age 13, the unstandardized Beta, B = 0.858, SE = .210, Wald = 16.762, P< 0.001, the estimated odds ratio indicates more than double (136%) increase [Exp (B) = 2.359, 95% CI (1.564, 3557)] in the odds that the youth will use e-cigarettes. Thus, at age 13, the Texas adolescent were 1.36 times more likely to use e-cigarettes than at age 11 (the reference category). By age 15, the odds of e-cigarettes use had more than tripled (365%) [Exp (B) = 4.648, 95% CI (2.915, 7.412)], and the adolescent has 3.6 times more likelihood of using e-cigarettes than at 11

years of age.

The predictor variable grade level was also noted to significantly predict e-cigarette use at the high school grade levels. At grade level 9, the estimated odds ratio was 1.61, and it was statistically significant (P=0.008) [Exp (B) = 1.61, 95% CI (1.133, 2.303)]. Therefore, high school grade 9 students were 0.61 times more likely than middle school grade 6 students (reference category) to use e-cigarettes, while at high school grade level 12, the estimated odds ratio was 2.72, and it was statistically significant (P=0.000) [Exp (B) = 2.72, 95% CI (1.751, 4.231)]. Therefore, high school grade 12 students were 1.72 times more likely to use e-cigarettes in comparison to the reference grade level 6.

In Chapter 5, the findings from this study were discussed. Suggestions for social change and recommendations for future research study were also presented.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The U.S. Surgeon General report in 2016 called e-cigarette use an epidemic engulfing the youth (U.S. Department of Health and Human Services [USDHHS], 2016). This indicates that e-cigarette use among the adolescents has become a widespread health problem for this population. Following its introduction into the U.S market in 2007 (Arrazola, 2015), e-cigarettes have been the most often used tobacco product among the youth (CDC, 2015a). According to the Centers for Disease Control and Prevention (Office of Smoking and Health, 2020), approximately 3.6 million youth in the United States currently use e-cigarettes, including about 20% of the high school population. In the state of Texas, approximately 32.5% of high school students and 11.3% of middle school students reported having ever used e-cigarettes (Texas Department of State Health Services (2019).

The purpose of this study was to examine the potential association between the sociodemographic factors age, gender, grade level, ethnicity, and race (independent variables) and e-cigarette use (dependent variable) among adolescents in Texas. Secondary data analysis of the 2018 Texas YTS of youth enrolled in middle and high schools of Texas public schools was conducted. To examine the possible relationship between adolescent e-cigarette use and sociodemographic factors, five research questions were answered by using the Pearson's Chi-Square test and BLR. To eliminate the

influence of potential confounders, the covariates socioeconomic status (SES) and area of residence (AOR) were included in the regression analysis. In this chapter, I will interpret the study findings, discuss the study limitations, make recommendations for future research, and provide the implications for social change.

Interpretation of the Findings

E-cigarette use has continued to be on the rise among the adolescent population of the United States (Cullen et al., 2019). In the 2018 TYTS, 43.8% of Texas students (11.3 % of middle school and 32.5% of high school students) reported having used e-cigarettes.

For each research question, the data were analyzed using cross tabulation, and the research question was answered using the Pearson Chi-Square test. Research Question 1 aimed at determining the relationship between age and e-cigarette use among Texas adolescents. In the 2018 TYTS, the age of sample participants ranged from 11 to 18, and the cross-tabulation showed how e-cigarette use varied by participant age. The crosstabulation (Table 2a) showed that 4.8% of participants aged 11 years used e-cigarettes, 6.0% among 12-year-olds, 12.3% among 13-year-olds, 18.1% among 14-year-olds, 27.2% among 15-year-olds, 29.5% among 16-year-olds, 36.2% among 17-year-olds and 42.1.3% among 18-year-olds. In addition to bivariate analysis, BLR was conducted to examine the relationship between e-cigarette use and age, while controlling for the other variables in the model.

The results of both the bivariate analysis and the regression modeling showed that a statistically significant relationship existed between e-cigarette use and age of adolescents in Texas. When compared with the reference group (Age 6), it was noted that with increasing age of the study participants, there was an increased probability of e-cigarette use ($P < 0.01$). Older Texas adolescents were more likely to use e-cigarettes than the younger adolescents. It was therefore concluded that there was a relationship between age and e-cigarette use among Texas adolescents, and the null hypothesis of no association was rejected.

Research Question 2 asked about a relationship between gender and e-cigarette use. The results of both the bivariate analysis and the regression modeling showed a borderline significant relationship ($P=0.05$), as there was a slight decrease in the probability of e-cigarette use among females in comparison with the male reference category. I therefore concluded that there was a weak relationship between gender and e-cigarette use among Texas adolescents and rejected the null hypothesis of no association.

Research Question 3 asked about an association between grade level and e-cigarette use. The results of the Chi-Square test showed there was a statistically significant relationship ($P < 0.001$) between the variables, with e-cigarette use increasing with increasing grade level. In the regression modeling, there was no statistically significant difference between grade levels 7 and 8 and grade level 6, but statistically significant differences emerged as the grade level increased from there, with grade levels

9 and 10 ($P<0.05$) and grade levels 11 and 12 ($p<0.01$) manifesting statistically significant difference from the reference grade level 6. Based on this discovery, the null hypothesis was rejected. This finding that Texas adolescents in high school (grades 9-12) were more likely to use e-cigarettes than middle school students was in agreement with previous reports (Cooper et al., 2018; Texas Department of State Health Services, 2019).

Research Question 4 examined the association between ethnicity (Hispanic vs Non-Hispanic) and e-cigarette use among Texas adolescents. Both the bivariate analysis and BLR showed a statistically significant relationship ($P<0.001$), with Hispanics being 22% less likely than non-Hispanics to use e-cigarettes.

In Research Question 5, the association between race and e-cigarette use was analyzed with White race as the reference category. Among all the races that were involved in the survey, only the Asians ($P<0.01$) and African Americans ($P<0.001$) showed negative statistically significant differences in e-cigarette use in comparison with Whites. Asians were 48% less likely, and African Americans were 40% less likely than Whites to use e-cigarettes.

The covariates AOR (coalition vs. non-coalition residence) and SES of Texas adolescents were also analyzed in relation to e-cigarette use, and both variables were included in the regression modeling analysis to control for their effects on other variables. The results of the bivariate analysis showed a significant association between SES and e-cigarette use, as well as between AOR and e-cigarette use. However, the modeling

analysis did not detect any association between the two covariates and e-cigarette use. This suggests that adolescent e-cigarette use was not influenced by their SES or where they resided.

Findings in the Context of the Literature

The findings from the current study are consistent with some findings in the literature. In national population surveys (Alcala, Albert, & Ortega, 2016; Giovenco, Lewis, & Delnevo, 2014), it was found that non-Hispanic whites were more likely to use e-cigarettes than Hispanics, an observation also noted in the current study. Similarly, as discussed in the literature review, earlier data from CDC (2015a) reported a lower smoking prevalence of 11.2% among Hispanics in contrast to 18.2% among non-Hispanic whites, while more recently, prevalence of 14.2% among non-Hispanic Whites and 10.1% among Hispanics was noted (Wang et al., 2018). Park, Lee, and Min (2017) noted a significant positive relationship between higher grade levels and greater odds of e-cigarette use, which is consistent with the finding from the current study. Wang et al. (2018) reported higher prevalence among non-Hispanic White males. Furthermore, in the recent National Youth Tobacco Survey (Cullen et al 2019), e-cigarette use prevalence was higher among high school students (27.5%) and lower in the middle school (10.5%).

There are, however, inconsistent reports in existing studies regarding the relationship between gender and e-cigarette use. As in the current study, some existing reports (Pineiro et al., 2017) also noted small gender differences in e-cigarette use,

leading to a conclusion that adolescent e-cigarette use was similar among men and women, whereas in other studies (Littllefield et al., 2015; Park, Lee, & Min, 2017), researchers reported that men had greater odds of e-cigarette use. Wang et al. (2018) also reported higher prevalence of e-cigarette use among non-Hispanic White men than among non-Hispanic White women. Kong, Kuguru, and Krishnan-Sarin (2017), however, concluded that although smoking has been traditionally higher among the male gender, there has been a narrowing of the gender gap in recent times. The inconsistent reports regarding gender differences require further investigation in future studies.

Findings in the Context of the Theoretical Framework

Ajzen's TPB (1991) has been extensively used to study human decision making for behavioral change. In this study, TPB was used to provide an understanding of e-cigarette use among adolescents 11 to 18 years old enrolled in Texas public schools. My analysis of secondary data from TYTS found associations between the predictor variables age, grade level, and race with e-cigarette use among Texas adolescents. E-cigarette use is a behavioral issue of conscious willingness (Park, Lee & Min, 2017; Pineiro et al., 2017) which can be precipitated by several characteristics of the individuals (Mazloomy, Jadgal, & Movahed, 2017; Hasan et al., 2019) including socio-demographic factors such as age, gender, grade level, ethnicity, and race, as investigated in this study. As posited by TPB, the intention of an individual to perform or avoid an action is perpetuated by the attitude towards that behavior, the subjective norms (such as peers and family) associated

with performing that behavior, as well as the control the individual has over the behavior (for instance, individual's control over e-cig use or non-use).

From the results of the 2018 TYTS, it was noted that 25.7 % of the youth did not consider e-cigarette use to be dangerous, and this attitude could be a precipitating factor that promotes e-cigarette use in Texas adolescents. The 2018 TYTS report further showed that 29.5% of the youth lived in the same home with a smoker, while 39.1% of peers/ friends used e-cigarettes, both of which are subjective factors in TPB that can promote the likelihood of e-cigarette use. The third construct of TPB, behavioral control, is the ability of the individual to control undertaking a behavior. From the 2018 TYTS, 40.3% of the participants admitted not being able to control tobacco use. Sociodemographic factors can influence the individual's attitude, subjective norm and perceived behavioral control, thereby increasing the intention to use e-cigarettes. Thus, the TPB has provided an understanding of adolescent characteristics and e-cigarette use.

Limitations of the Study

There were several limitations in this study. Participants in the survey were only from the middle and high schools in Texas public schools. Adolescents enrolled in private schools or even in correction centers were not considered. This latter population can be at particularly high risk for ECU, but relevant data from these individuals were not captured. This would make the findings not be generalizable to the entire adolescent population in Texas. In addition, the original data were generated from a cross-sectional

study which measure events at a specific point, without any follow-up of the participants. Thus, one cannot delineate any cause-and-effect relationship between the variables.

The data were self-reported and were therefore limited by the truthfulness of the respondent/ participants as well as by their ability to recall e-cigarette use. In addition, the survey questions were quantitative and closed-ended, thereby limiting the extent of information the participants could provide. Finally, this study was only able to control for two potential confounders (SES and AOR), as these were the only ones included in the primary data collection, making it impossible to control for other potential confounding variables.

Recommendations

My study aimed at examining how e-cigarette use by Texas adolescents is affected by sociodemographic factors. Although several public health campaigns have been developed for preventing e-cigarette use, including various state-funded and national-level, anti-tobacco campaigns, results from both the National and the Texas YTS have continued to show increased e-cigarette use among adolescents. This continued surge in e-cigarette use calls for more targeted programs and policies to mitigate this behavioral problem of e-cigarette use by adolescents. It is recommended that public health education on the dangers associated with e-cigarettes should be intensified at all school and facilities where adolescents can be located. For instance, noting that the findings from this study showed that e-cigarette use is more likely in adolescents in

higher grades (grades 11 and 12), targeted health promotion programs should be designed specifically for students in these grades. it would also be prudent for public health officials to incorporate use of social media in providing education about adverse effects of e-cigarettes to enhance information reaching the target population.

Product marketing and advertisements by tobacco companies could have major impact on the youth. It is therefore recommended that future studies should examine the effect of advertisement and marketing of tobacco products on the increasing prevalence of ECU among adolescents. Considering that behavioral problems occur in peers, it is also recommended that the health promotion should include peer-led programs that can help to increase the participation of other adolescents as well as improve the sustainability of the health promotion program. Preventing the initiation of e-cigarette use in the first place could help to reduce the e-cigarette epidemic among young people. With several anti-smoking campaigns in existence, public policy administrators should endeavor to select programs that have been effective for utilization in the target population. It is also recommended that in addition to quantitative research, it would be important to utilize a qualitative approach to understand the adolescent's perspective regarding e-cigarettes use.

Gender difference in e-cigarette use was noted to not be significant in this study. However, considering that there are several types of e-cigarettes, future studies should investigate the patterns of use of different types of e-cigarettes by gender as this may

provide more direction for public health practitioners in developing audience-specific targeted education. The inconsistent literature reports regarding gender differences in e-cigarettes use require further investigation in future studies. To further ensure the generalizability of the findings, there should be expansion of the eligibility criteria in order to accommodate more adolescent populations, including those in private schools, for future surveys.

Implications for Social Change

The current study has the potential for positive social change among adolescents and the prevention of e-cigarette use by providing information that can be useful for the development of targeted interventions to mitigate adolescent e-cigarette use. Preventing the initiation of e-cigarette use in the first place is paramount and should be the focus for developing evidence-based interventions for the adolescent population. Policy changes that would target adolescent health promotion would further help to motivate the adolescents to make behavioral change towards avoiding ECU.

Provision of health education can help to enhance their self-worth, thereby enabling them to refrain from harmful/ unhealthy behaviors such as e-cigarette use. Considering the impact of social norms (peer and family/ significant other) in the adoption of behaviors, peer education and family involvement would be integral aspects of health promotion interventions. The findings from this study will be disseminated through peer-reviewed journal publication to add to the current knowledge regarding

sociodemographic factors and ECU among adolescents, and also provide information for future studies that can address additional gaps in this research topic.

Conclusion

The purpose of this study was to examine the potential association between the variables age, gender, grade level, ethnicity, and race (independent variables) and e-cigarette use (dependent variable) among adolescents in Texas. Bivariate analyses and BLR were undertaken using secondary data from TYTS. Five research questions were examined. The study provided descriptive and inferential data for the participants of the TYTS. The study found significant relationships between four (age, grade level, ethnicity, and race) of the five independent variables and the dependent variable, while only noting a weak relationship between the independent variable gender and the dependent variable e-cigarette use.

The independent variables of age and grade level showed the most significant associations with e-cigarette use. As the age and grade level of the adolescents increased, they were more likely to use e-cigarettes. The age (which aligns with the grade level) of the adolescent is therefore a major contributing factor to e-cigarette use among adolescents. The findings from this study may provide important implication for intervention. Preventing the initiation of e-cigarettes use could help to reduce the e-cigarette epidemic among young people.

This study has provided additional understanding about factors that can lead to increased use of e-cigarettes. This knowledge may help public health professionals in developing appropriate audience-targeted health education materials and intervention programs. The findings from the current study will contribute to the knowledge base pertaining to the association of sociodemographic factors with e-cigarette use by providing additional understanding of factors associated with adolescent ECU.

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