2018

Who's Vaping Now? Relationship between Ever and Current E-Cigarette Use and Demographic, Social, Economic, Health Characteristic and Behavior Indicators

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WHO'S VAPING NOW? RELATIONSHIP BETWEEN EVER AND CURRENT E-CIGARETTE USE AND DEMOGRAPHIC, SOCIAL, ECONOMIC, HEALTH CHARACTERISTIC AND BEHAVIOR INDICATORS

BY

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A doctoral project submitted to the faculty of the Medical University of South Carolina in partial fulfillment of the requirements for the degree Doctor of Health Administration in the College of Health Professions

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Acknowledgments

I am forever appreciative to my dear friend at the National Center for Health Statistics; thank you, your guidance and assistance throughout my research helped me every step of the way. I am grateful to my chair, Dr. James Zoller, committee members, Dr. Bernard Parker and Dr. Eugene Hayes, editor, Dr. Carolyn Rose-Smith, for their assistance and being flexible as I pursed this degree and my career at the same time. I want to thank the staff at the Medical University of South Carolina Writing Center, for helping with edits through various iterations of this manuscript. A very special gratitude to Anthony Hawes and aunt Linda for the countless discussions, advice and tireless reading of drafts. To my parents, Sandra and Michael, thank you for your motivation and encouragement to advance my studies to be the first in my family to achieve a doctoral degree. To other family members, colleagues and friends, thank you for your support and kindness throughout this academic journey.

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Medical University of South Carolina
In Partial Fulfillment of the Requirements for the
Degree of Doctor of Health Administration

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Scientific information about e-cigarettes is limited; thus, insufficient safety and efficacy research on e-cigarettes is one reason that the products have attracted controversy. Although the scientific, regulatory, and lay communities have been passionate in their responses to e-cigarettes, they are divided, with some advocating their use based on the harm reduction approach and others arguing against use based on the precautionary principle. The purpose of this cross-sectional research study was to examine the relationship between e-cigarette use (ever/past and current) and social, economic, and health behavior indicators. Flay and Petraitis' Theory of Triadic Influence served as the theoretical foundation of this study. The 2014 and 2015 National Health Interview Survey data were used. Data were analyzed using logistic regression analyses. Results indicated that apart from employment status, there are significant relationships between ever/past and current e-cigarette use and demographic, social, and economic indicators. In addition, apart from body mass index and leisure-time physical activity, there are

significant relationships between ever/past and current e-cigarette use and health indicators. Findings from this study are directed at public health policy makers and experts to improve understanding of the demographic, social, economic, and health characteristics and behavior indicators associated with e-cigarette use.
Keywords: E-cigarettes, demographic, social, economic indicators, health characteristics and behavior indicators, cross-sectional research study, theory of triadic influence

CHAPTER 1
INTRODUCTION

Despite significant advances in the recognition that cigarette smoking has adverse effects on people's health and well-being, it continues to be one of the largest health problems in the world (Forman-Hoffman, Hedden, Glasheen, Davies, & Colpe, 2016; World Health Organization [WHO], 2013). Zhong, Cao, Gong, Fei, and Wang (2016) reported that in 2013, tobacco use was the second most important risk factor for global disease burden, accounting for 6.1 million deaths and 143.5 million disability-adjusted life years (DALYs) across the world (p. 465). Ruiz, Graff, and Robinson (2016) related that cigarette smoking causes or worsens various chronic respiratory, neoplastic, and cardiovascular diseases, which result in approximately 480,000 premature deaths each year in the United States (p. 544). When the link between smoking and cancer was established in the 1940s and 1950s, warnings from medical doctors combined with effective antismoking ad campaigns from public health experts and agencies sharply reduced cigarette consumption in the United States (U.S. Department of Health and Human Services [HHS], 2014). Jamal et al. (2016) indicated that cigarette smoking among U.S. adults declined from 20.9% (45.1 million adults) in 2005, to 15.1% (36.5 million adults) in 2015, which was a 27.7% decline (para. 4).

Electronic nicotine delivery systems, (ENDS), also known as electronic cigarettes, e-cigarettes, e-cigs, vape pens, e-cigars, e-hookah, or vaping devices, have emerged as a potential public health crisis that could negatively affect reductions in tobacco smoking

(American Academy of Pediatrics [AAP], 2016; Longo, Dinaker, & O'Connor, 2016). ENDS are devices that produce aerosolized mixtures of flavored liquids and nicotine for inhalation by users; these devices function as cigarettes, cigars, or pipes, but resemble common gadgets such as flashlights, flash drives, or pens (AAP, 2016). Aerosolized means "to disperse as an aerosol" (Aerosolized, 2018, para. 1). In this cross-sectional research study, these products will be consistently referred to as *e-cigarettes*.

Lik, a Chinese pharmacist, invented e-cigarettes in China in 2003 to help him quit smoking due to his father's lung cancer diagnosis (Geller, 2015). Martin (2012) reported that e-cigarettes have been marketed in the United States since 2007 with minimal regulation. The author noted that electronic cigarettes are battery-operated devices that heat up a liquid containing nicotine and other chemicals into an aerosol that is delivered to the user as a flavored or unflavored vapor. Martin reported that puffing on an e-cigarette is often referred to as vaping, and bystanders can inhale this vapor when users exhale. Martin explained that these devices can resemble a conventional cigarette and are a disposable or rechargeable smoking option that may change how tobacco products are consumed in the United States.

Health and medical claims that e-cigarette use can result in smoking cessation are unsupported by scientific evidence (Grana, Benowitz, & Glantz, 2014). Grana, Popova, and Ling (2014) conducted a longitudinal analysis of a national sample of current U.S. smokers to determine whether e-cigarette use predicted successful quitting or reduced cigarette consumption. Specifically, Grana, Popova, et al. investigated predictors of quitting among a national sample of 949 smokers who participated in a 2011 study and

2012 follow-up. The researchers found that current e-cigarette use (past 30 days) at baseline did not predict a greater likelihood of having quit at the follow-up.

The purpose of this cross-sectional research study was to examine the relationship between e-cigarette use (ever/past and current) and demographic, social, economic, health characteristic and behavior indicators using the 2014 and 2015 National Health Interview Survey (NHIS) data. NHIS is a large, multipurpose, cross-sectional household-based health survey produced annually by the National Center for Health Statistics (NCHS). Outcomes may be used to assist healthcare industry experts address this emerging public health crisis with appropriate messages targeting the right audiences. In Chapter 1, the background and need, problem statement, research questions and research hypotheses, population, and assumptions will be discussed.

Background and Need

Lally (2017) reported that in the United States, e-cigarette sales are big business as sales were estimated at $1.5 billion in 2014, but have increased to $2.7 billion in 2015, and are expected to grow 24.2% each year through 2018 (para. 3). In 2009, the U.S. Food and Drug Administration (FDA) tried to block e-cigarettes' importation and sale, claiming they were unauthorized drug-delivery devices (Grana & Ling, 2014). Grana and Ling (2014) reported that the FDA was sued and in 2010, the U.S. Court of Appeals ruled that unless marketed for therapeutic purposes, e-cigarettes should be regulated as tobacco products. The researchers noted that in April 2011, the FDA stated its intent to exercise authority over e-cigarettes. The FDA (2017) reported a rule was finalized in 2016, where regulatory authority was extended over all tobacco products, including e-cigarettes,

vaporizers, vape pens, hookah pens, e-pipes, and all other ENDS. The FDA noted that they now regulate the manufacture, import, packaging, labeling, advertising, promotion, sale, and distribution of ENDS, which includes components and parts of ENDS, but excludes accessories. The FDA explained that products marketed for therapeutic purposes, such as marketed as a product to help people quit smoking, are regulated through the FDA's Center for Drug Evaluation and Research (CDER).

Public health officials are divided over whether e-cigarettes (a) are safer than tobacco cigarettes, (b) may serve as a gateway to cigarette smoking among adolescents, and (c) can be used for smoking cessation (Leventhal et al., 2016; Phillips, 2014; Yong et al., 2014). Yong et al. (2014) explained that evidence on e-cigarette effectiveness as a smoking cessation tool is both limited and mixed. The researchers related that quit rates of e-cigarette users were either similar to, higher, or lower than, nonusers of e-cigarettes. Yong et al. speculated that e-cigarette use could significantly reduce consumption among smokers who did not intend to quit.

The FDA has not issued any regulations on e-cigarettes as an aid in smoking cessation, but Grana and Ling (2014) examined websites that promoted or advertised e-cigarettes and reported 95% of these sites made explicit or implicit health-related claims regarding e-cigarettes (p. 395). Grana and Ling reported 64% of the sites claimed that e-cigarettes could be used as a smoking cessation tool and 22% featured a doctor on the site (p. 395). Because these claims have existed for as long as e-cigarettes, the claims very likely have served to promote e-cigarette use among adults in the United States. For example, Schoenborn and Gindi (2015) reported that e-cigarettes use was highest among

current and recent former cigarette smokers and among current smokers who attempted quitting in the previous year.

Reducing tobacco consumption is one of the biggest challenges for public health officials (Milcarz, Makowiec-Dabrowska, Bak-Romaniszyn, & Kaleta, 2017). Milcarz et al. (2017) observed that (a) informing stakeholders, (b) improving existing health policy and health care, and (c) development and implementation of effective tobacco control interventions requires meticulous analysis of detailed data pertaining to prevalence of use, the determinants of the tobacco epidemic, and the effectiveness of the programs implemented in relation to both the general and disadvantaged populations. The presence of toxic chemicals in the vapor of e-cigarettes has raised health concerns that e-cigarettes promote pulmonary inflammation, similar to other tobacco products (Higham et al., 2016). Despite these concerns, there remains much to be learned about the health effects of e-cigarette products among U.S. adults (McMillen, Maduka, & Winickoff, 2012). Researchers have reported that some smokers believe e-cigarettes are safer and less harmful than cigarettes (Choi & Forster, 2014; Pearson, Richardson, Niaura, Vallone, & Abrams, 2012; Tan & Bigman, 2014). Further research is needed to determine the potential health effects on individuals who use e-cigarettes as well as the effects on the general public (e.g., exposure to secondhand e-cigarette vapor).

Within such a broad theme requiring extensive investigations, one area of focus requiring analysis involves establishing if demographic and social characteristics, economic factors, and health characteristics and behaviors are associated with e-cigarette purchase and use. In this study, I investigated whether there was a relationship between

e-cigarette use (ever/past and current) and any of these indicators. For the purposes of analysis, demographic, social, and economic indicators include sex, age, race and ethnicity, region, education, poverty status, employment status, marital status, number of children in the family or household, and sexual orientation. Health characteristic indicators include self-reported health status, functional limitations or disabilities, serious psychological distress, and asthma (ever diagnosed with), while health behavior indicators include alcohol drinking status, meeting the 2008 federal physical activity guidelines through leisure-time physical activity (LTPA), body mass index (BMI), and smoking status. Findings will advance knowledge within the health administration field and may assist healthcare industry experts in developing effective campaigns that will either advance or discourage use of e-cigarettes, based on consensus of the medical community derived from results of objective clinical investigations of the health effects of e-cigarettes.

Problem Statement

Scientific information about e-cigarettes is limited; thus, insufficient safety and efficacy research on e-cigarettes is one reason that the products have attracted controversy (Fairchild, & Bayer, 2015; Green, Bayer, & Fairchild, 2016; Long et al., 2016; Zhu et al., 2013, 2014). In 2014, there were approximately 466 brands with varying contents of ingredients and 7764 unique flavors of e-cigarette products; such variation confounds analyses of potential health effects of e-cigarettes (Longo et al., 2016, p. 1372; Zhu et al., 2014). Thus, e-cigarettes, which became popular very quickly without major paid advertising, have attracted the attention of both smokers and tobacco

control workers (Cobb, Byron, Abrams, & Shields, 2010; Noel, Rees, & Connolly, 2011; Regan, Promoff, Dube, & Arrazola, 2011; Zhu et al., 2013).

Although the scientific, regulatory, and lay communities have been passionate in their responses to e-cigarettes, they are divided, with some advocating their use based on the harm reduction approach, arguing that e-cigarettes are less harmful than cigarettes and may be used to help smokers quit (Cahn, Z., & Siegel, 2011; Fairchild, & Bayer, 2015; Green et al., 2016; Longo et al., 2016; Wagener, Siegel, & Borrelli, 2012; Zhu et al., 2013). Although there are studies of smokers using e-cigarettes to help them quit smoking (e.g., Etter & Bullen, 2011; Foulds, J., Veldheer, S., & Berg, 2011; McQueen, Tower, & Sumner, 2011; Polosa, 2011; Siegel, Tanwar, & Wood, 2011), clinical trial data are still limited (e.g., Bullen et al., 2010; Caponnetto et al., 2013; Etter, Bullen, Flouris, Laugesen, & Eissenberg, 2011; Polosa et al., 2013; Vansickel, Weaver, & Eissenberg, 2012). Higham (2016) argued that while e-cigarettes are used to help reduce or stop tobacco smoking, there are toxic chemicals in the vapor, such as formaldehyde and acrolein, which cast doubt on the safety of using e-cigarettes. Others have argued the precautionary principle to avoid a new product adoption when the long-term effects of that product are unknown (Fairchild, & Bayer, 2015; Green, Bayer, & Fairchild, 2016; Longo et al., 2016). Thus, researchers have argued that it is not clear that promoting e-cigarette use would reduce the total harm associated with tobacco use at the population level (Lund, Scheffels, & McNeill, 2011; Zhu et al., 2009, 2013). In addition, researchers have argued that promoting the use of any tobacco product promotes the use of tobacco, which would result in "a negative net-effect on tobacco control at the population level"

(Mejia, Ling, Glantz, 2010; Zhu et al., 2013, p. e79333). As a result, researchers have suggested that more data are needed on e-cigarette safety before they are promoted and sold (Cobb et al., 2010; Zhu et al., 2013).

Therefore, it is important to understand the prevalence of e-cigarette usage among U.S. adults and the factors associated with their use. Using Flay and Petraitis' (1994) theory of triadic influence (TTI) as the theoretical foundation, a cross-sectional research study based on a large, recent, nationally representative sample of U.S. adults that examines the relationship between ever/past and current e-cigarette use and demographic, social, economic, health characteristics and behavior indicators should prove informative. Findings from this study are directed at public health policy makers and experts as sound scientific evidence regarding the risk factors associated with e-cigarette use remains deficient. By understanding the demographic, social, economic, and health characteristics and behavior indicators associated with e-cigarette use, healthcare industry experts will be better able to address the emerging public health crisis with accurate claims aimed at the appropriate target audiences.

Research Questions and Research Hypotheses

To examine the relationship between e-cigarette use (ever/past and current) and demographic, social, economic, and health indicators in this cross-sectional research study, the following research questions and hypotheses are addressed:

1. **What factors, if any, are related to ever/past e-cigarette use?**

   H_0: There is no significant relationship between ever/past e-cigarette use and demographic, social, and economic indicators.

H_a: There is a significant relationship between ever/past e-cigarette use and demographic, social, and economic indicators.

H_0: There is no significant relationship between ever/past e-cigarette use and health characteristic indicators.

H_a: There is a significant relationship between ever/past e-cigarette use and health characteristic indicators.

H_0: There is no significant relationship between ever/past e-cigarette use and health behavior indicators.

H_a: There is a significant relationship between ever/past e-cigarette use and health behavior indicators.

2. What factors, if any, are related to current e-cigarette use?

H_0: There is no significant relationship between current e-cigarette use and demographic, social, and economic indicators.

H_a: There is a significant relationship between current e-cigarette use and demographic, social, and economic indicators.

H_0: There is no significant relationship between current e-cigarette use and health characteristic indicators.

H_a: There is a significant relationship between current e-cigarette use and health characteristic indicators.

H_0: There is no significant relationship between current e-cigarette use and health behavior indicators.

H_a: There is a significant relationship between current e-cigarette use and health behavior indicators.

Population

The 2014 and 2015 NHIS data were used to determine the prevalence of ever/past and current use of e-cigarettes among U.S. adults aged 18 years and older. The NHIS is a large, annual survey of the civilian noninstitutionalized adult population in the United

States and contains recent federal data available on e-cigarette use. The large, annual sample size of this survey, which includes approximately 40,000 responding households in any given survey year, is well-suited for conducting analyses of ever/past and current e-cigarette use by appropriate demographic, social, economic, and health characteristic and behavior indicators. The NHIS data covers the civilian noninstitutionalized population residing in the United States at the time of the interview. Because it is a household-based survey, several population segments are not included in the NHIS sample or in the estimates derived from the survey because they do not live in households (NCHS, 2016). Examples of individuals who are excluded from the survey (and thus the analysis) are patients in long-term care facilities; persons on active duty with the Armed Forces (but their dependents living in households in the U.S. could be included); imprisoned persons; and U.S. nationals living in foreign countries (NCHS, 2016); thus, findings cannot be generalized to these population segments.

Assumptions

Assumptions made for this study were the following:

- The cross-sectional research study design was appropriate to examine the relationship between e-cigarette use (ever/past and current) and demographic, social, economic, health characteristic and behavior indicators.
- It was assumed that the 2014 and 2015 NHIS data that was used in the study is both accurate and complete.
- The findings from the study may be generalized to the civilian, noninstitutionalized adult population in the United States.

- The results of the study may help healthcare industry experts address this continuing public health crisis with specific claims targeting appropriate audiences.

CHAPTER II
LITERATURE REVIEW

In this cross-sectional research study, the relationship between ever/past and current e-cigarette use and demographic, social, economic, and health characteristic and behavior indicators were examined using the NCHS's 2014 and 2015 NHIS data. Grana, Benowitz, et al. (2014) reported that the market penetration of e-cigarettes has been rapid despite many unanswered questions about their safety, efficacy (for harm reduction and smoking cessation), and overall effect on public health. The researchers noted that e-cigarette products are constantly altering; therefore, many findings from studies of older products may not be relevant to the assessment of newer products claimed as safer and more effective as nicotine delivery devices. In addition, Grana, Benowitz, et al. related that marketing and other environmental influences may differ among various countries; hence, patterns of use and the ultimate effect on public health may vary. Researchers have found that individual risks and benefits and the total effect of these products occur in the context of the widespread and continuing availability of conventional cigarettes and other tobacco products, and that adults and youths use both e-cigarettes and conventional cigarettes at the same time (Adkison et al., 2013; Centers for Disease Control and Prevention [CDC], 2013; Dockrell, Morrison, Bauld, & McNeill, 2013; Dutra & Glantz, 2014; Grana, Benowitz, et al., 2014; King, Alam, Promoff, Arrazola, & Dube, 2013; Lee, Grana, & Glantz, 2013; Pearson et al., 2012; Regan et al., 2011).

It is important to evaluate e-cigarette toxicant exposure and individual risk, as well as the health effects of e-cigarettes, and develop an evidence-based regulatory plan

that protects the public, including children, adults, smokers, and nonsmokers (Grana, Benowitz, et al., 2014). Phillips (2014) reported that although e-cigarettes have also been defined as being harmless replacements for regular cigarettes, opinions differ among the tobacco industry, healthcare experts, and smokers regarding how e-cigarettes are marketed, how they should be regulated, who should use them, and the potential future health effects on individuals who use them as well as any secondhand smoke issues. Grana, Benowitz, et al. (2014) noted that health and efficacy claim for the use of e-cigarettes for smoking cessation are unsupported by the scientific evidence to date. Grana, Benowitz, et al. argued that to decrease the potential negative effects on prevention and cessation and the undermining of current tobacco control measures, e-cigarette use should be prohibited where tobacco cigarette use is prohibited, and the products should be subjected to the same marketing restrictions as tobacco cigarettes.

In Chapter 2, the method used to search the literature; the theory of triadic influence, which serves as the theoretical foundation of this study; and the literature review, which summarizes previous research on e-cigarettes, e-cigarette use and demographic, social, and economic indicators, as well as e-cigarette use and health characteristic and behavior indicators will be discuss. A summary and conclusions are included.

Method

The literature search strategies for this research included a comprehensive search in the Medical University of South Carolina databases to include PubMed, Medline Plus, Cochrane Database of Systematic Reviews, and ProQuest Health Management. In

addition, searches through Google Scholar and books on electronic cigarettes were conducted. Search terms included *e-cigarette and sex and age and race and ethnicity*, *e-cigarette and education*, *e-cigarette and marriage*, *e-cigarette and poverty*, *e-cigarette and employment*, *e-cigarette and household*, *e-cigarette and region*, *e-cigarette and health status*, *e-cigarette and mental health*, *e-cigarette and functional limitations*, *e-cigarette and asthma*, *e-cigarette and body mass index*, *e-cigarette and alcohol*, *e-cigarette and physical activity*, *e-cigarette and smoking status*, *e-cigarette and social economic*, *e-cigarette and health behavior*, and *e-cigarette and theory of triadic influence*. Focus was placed on obtaining current articles within the last 5 years.

Theoretical Foundation

Flay and Petraitis' (1994) TTI served as the theoretical foundation of this cross-sectional research study. HHS (2012) reported that the processes by which tobacco marketing affects tobacco use are complex and dynamic, but can be understood in relation to existing theories of health behavior. HHS noted that a TTI premise is that health and risk behaviors are direct products of intentions. Hence, behaviors such as experimentation with smoking and initiation underlie the process to begin smoking or not to smoke. In this section, TTI theory and how the theory has been applied in previous studies that are similar to this current study is discuss and later discuss the results of the current study by relating it to the TTI as well as the literature review in Chapter 5. This section is organized in the following subsections: theory of triadic influence and research application of theory of triadic influence.

Theory of Triadic Influence. This subsection is organized in the following areas: overview, three levels of causation, and three streams of influence.

Overview. People who focus on health promotion should know what causes health-related behaviors (HRBs) and how to successfully promote health-enhancing behaviors or discourage health-compromising behaviors (Flay, Snyder, & Petraitis, 2009), such as smoking e-cigarettes. This knowledge has been evasive because (a) there are many and different causes of behavior as each cause is only one piece among various causes; (b) different behavior theories have focused on different aspects of the puzzle; (c) theories are difficult to confirm, which causes uncertainty; and (d) the theory scope limits the translation of any theory into health promotion programs; thus, narrowly focused theories result in narrowly focused interventions (Flay et al., 2009; Petraitis, Flay, and Miller, 1995). Due to the complex mass of theories and variables that focus on substance use, Petraitis et al. (1995) reported that they extensively examined the literature and found that variables can be organized along two dimensions: (a) levels of causation and (b) streams of influence. Flay and Petraitis (1994) proposed the TTI to acknowledge numerous behavioral influences and to provide a structured and testable integrated theory. Snyder and Flay (2012) explained that the TTI is organized in a cogent 3 × 3 framework, which includes three levels of causation and three streams of influence.

Three levels of causation. Independent variables or factors that might influence individuals to smoke are at three distances from actual smoking behaviors: (a) ultimate, (b) distal, and (c) proximal (Flay et al., 2009; HHS, 2012; Snyder & Flay, 2012). HHS (2012) noted that ultimate factors represent the underlying causes of health and risk

behaviors, which includes smoking. Snyder and Flay (2012) reported that at the ultimate level, causes are broad and quite stable, and that individuals have little control over, such as their cultural environment. In addition, ultimate or underlying causes are the furthest removed from behavior, for example, biological susceptibility, poverty rates, politics, policy, religions, cultural practices, mass media, socioeconomic status, modern society's pursuit of economic growth, age, ethnicity, and personality (Flay et al., 2009; Snyder & Flay, 2012). Snyder and Flay noted that their effects are the most pervasive as they influence many behaviors, are the most mediated, and frequently the most difficult for any individual or program to change. However, Snyder and Flay noted that if changed, these causes are likely to have the most enduring influence on a broad range of behaviors. The debate over the effects of nature and nurture on behavior normally focuses on ultimate causes (Flay et al., 2009; Institute of Medicine, 2006). Snyder and Flay related that ultimate-level causes can vary among different locations; for example, urban dwellers may have different ultimate levels of influence than people in rural areas.

Distal factors include those that predispose individuals to smoke, including peer influence, self-esteem, and cultural norms (HHS, 2012). Distal-level influences are a step closer to behavior and are variables that affect behavior that individuals are likely to have some control over (Flay et al., 2009; Snyder & Flay, 2012). The first level of distal causes is at the social-personal nexus that includes, for example, general self-control, bonding to parents, deviant role models, rebelliousness, and religious participation (Flay et al., 2009; Snyder & Flay, 2012). These are variables that reflect the quality and quantity of contact between individuals and their sociocultural environments, social

situations, or personality (Flay et al., 2009; Snyder & Flay, 2012). Snyder and Flay (2012) discussed a subcategory of distal-level influences called second-order distal influences, which are another step closer to behavior and are a set of affective or cognitive influences termed evaluations and expectancies. The researchers shared that these are general values and behavior-specific evaluations as well as general knowledge and specific expectations or beliefs that result from the contact between people and their surroundings.

Proximate factors are process components that tend to immediately precede behavioral change, such as attitudes, beliefs, and intentions (HHS, 2012). Snyder and Flay (2012) explained that proximal-level predictors are more immediate precursors to a specific behavior and are under people's control, but are still influenced by distal and ultimate factors. The researchers noted that based on TTI, decisions, intentions, and experiences have a direct effect on a specific behavior. Snyder and Flay related that while all three levels influence behavior, the proximal level tends to be more directly predictive of specific behaviors.

Three streams of influence. Factors that promote or deter smoking and other health behaviors can be organized into three interacting but distinct streams: (a) intrapersonal, (b) social-contextual, and (c) cultural-environmental (Flay et al., 2009; HHS, 2012; Snyder & Flay, 2012). The intrapersonal stream starts at the ultimate level and involves biological and personality-related factors that serve as risk or protective factors for smoking (HHS, 2012; Snyder & Flay, 2012). These factors can include self-concept, self-esteem, testosterone levels, tendency to take risks, openness to experience,

consciousness, extraversion, agreeableness, and neuroticism (HHS, 2012; Snyder & Flay, 2012). Snyder and Flay (2012) shared that based on the TTI, these ultimate-level intrapersonal causes have direct effects on social and personal nexus variables in the intrapersonal stream, including self-esteem and general competencies such as locus of control. The researchers noted that these intrapersonal variables have direct effects on variables such as self-determination and general skills. Snyder and Flay noted that these distal influences in the intrapersonal stream are more targeted to a specific behavior and the variables form people's sense of self-efficacy about a particular behavior.

"The social-contextual stream starts with social situations, which provide context for dynamic interactions with other people, their actions, and their beliefs, and ends with individual's social normative beliefs that directly influence their behavioral intentions" (HHS, 2012, p. 509). Snyder and Flay (2012) related that the interpersonal stream begins with ultimate-level characteristics of people's immediate social surroundings that are mostly outside individuals' control. The researchers explained that it continues through social and personal nexus variables in their immediate social surroundings, including the strength of the interpersonal bonds with immediate role models and the pertinent behaviors of those role models, such as parents. Snyder and Flay shared that the flow then continues through variables that include motivation to comply with various role models such as family members or peers, and perceptions of what behaviors those role models are encouraging. Next, the researchers noted that social influences form social normative beliefs about the specific behavior; thus, individuals' views of social pressures to take part in a particular behavior.

The cultural-environmental stream includes macrolevel factors and processes such as cultural convention, societal practices, and public policy, which influence people's attitudes and perceptions about tobacco use (HHS, 2012). Snyder and Flay (2012) reported that this stream follows the same pattern as the previous two streams, which begins with broad cultural characteristics that are mostly beyond people's control. The researchers noted that cultural-environmental stream flows into variables such as the nature of the interactions people have with social institutions such as political, legal, religious, and governing systems, and the information and values they gather from their culture, for example, what they learned from mass media exposure. Snyder and Flay indicated that the cultural-environmental stream then flows through variables related to the consequences people expect from a behavior and how one evaluates the different consequences of a behavior. The researchers noted that these influences form people's attitude toward a specific behavior.

Interaction of the three streams of influence can be understood from the literature that congruence or incongruence between people's self-image and their stereotype of smokers predict whether they will become smokers (Aloise-Young & Hennigan, 1996; HHS, 2012). HHS (2012) shared that stereotypes of smokers come from the social and environmental streams of influence, which interacts with the intrapersonal stream to influence tobacco use. The tobacco industry promotes smoking through advertising, direct marketing, and industry-sponsored smoking prevention advertisements, which act at multiple levels and points within the TTI framework (HHS, 2012; Landman, Ling, & Glantz, 2002; Wakefield et al., 2006). HHS (2012) reported that tobacco promotion can

have a direct influence on social-contextual and cultural-environmental streams. HHS noted that tobacco promotion can influence adolescents during the early stages of their development when they form attitudes and beliefs about tobacco. HHS related that at this level, tobacco advertising and promotion influence is through mediated pathways. Hence, distal-level factors are directly influenced by advertising, promotion, industry-sponsored antismoking ads, and smoking in movies, such as exposure to other smokers, peer attitudes, cultural practices, and positive and negative beliefs about smoking consequences. Consequently, HHS indicated that researchers who use peer and family smoking as independent variables understate advertising effects. HHS explained that these distal-level factors carry the tobacco industry influence to actual intentions and behavior. HHS noted consistency between the pathways of influence and Flay's (1993) five stages of the initiation and continuation of smoking among adolescents as described in HHS (1994) surgeon general's report.

At the lower levels in the TTI framework, industry marketing activities also act as a process moderator (HHS, 2012). Specifically, repeated exposures to advertising, promotion, and smoking in the movies can amplify the effects of the industry's influences on the social-contextual and cultural-environmental streams of influence. For instance, HHS (2012) discussed proximal factors where some industry-sponsored antismoking ads seem to influence people's perceptions and attitudes about smoking in ways that encourage smoking, thus, influencing the cultural-environmental stream. Thus, smoking in the movies can influence both social-contextual and cultural-environmental streams. HHS noted that the relationship between industry marketing, depictions of smoking in

movies, and adolescent smoking are moderated mediation pathways. Hence, HHS explained that distal factors such as peer influence, family, and culture mediate influences of advertising, promotion, and smoking in the movies and that mediation effect on proximate factors is moderated by more exposure to the influence of the tobacco industry and depictions of smoking. HHS noted that anti-tobacco media campaign effectiveness also supports this model for the pro-tobacco advertising and promotion effectiveness, as anti-tobacco media operate through the similar channels. HHS related that anti-industry messages tend to reduce the tobacco industry's ability to shift attitudes toward smoking and tobacco use, thus, creating momentum against tobacco use. HHS emphasized the importance of evaluating all TTI components, especially, the need to monitor tobacco companies' activities and efforts to prevent young people's tobacco use.

Research application of theory of triadic influence. Tobacco companies were one of the earliest companies to identify and implement effective, integrated marketing strategies, and cigarettes and other tobacco products have been among the most marketed consumer products in the United States (Brandt, 2007; HHS, 2012). HHS (2012) discussed the evidence on the effect of tobacco companies' marketing activities on tobacco use, which includes e-cigarettes. HHS used the TTI as the theoretical framework that relates tobacco companies' advertising and promotion to tobacco use among young people. HHS concluded that in 2008, for the marketing of cigarettes, tobacco companies spent $9.94 billion, and for smokeless tobacco, they spent $547 million (p. 601). HHS found that compared to 1998, spending on cigarette marketing was 48% higher, while the cost to market smokeless tobacco was 277% higher (p. 601). HHS concluded that there

was a causal relationship between tobacco companies' advertising and promotional efforts and the initiation and progression of tobacco use among young people. However, HHS found that while the evidence was suggestive, it was not sufficient to conclude that tobacco companies have changed the packaging and design of their products in ways that have increased these products' appeal to adolescents and young adults. HHS also found that tobacco companies' activities and programs for the prevention of youth smoking have not shown an effect on the initiation or prevalence of smoking among young people. However, HHS indicated that there is enough evidence to conclude that there was a causal relationship between depictions of smoking in the movies and young people beginning to smoke.

In epidemiological studies where researchers examined smoking, results indicated that the higher rates of smoking among youth and young adults is often a universal finding (Hammond, 2005; Subramaniam et al., 2015; Substance Abuse and Mental Health Services Administration [SAMHSA], 2011). Subramaniam et al. (2015) explored the perceptions of smokers aged 14 to 29 years in Singapore regarding the context of smoking initiation and maintenance while living in a multiethnic Asian country. The researchers conducted focus group discussions in English with 91 smokers in this age group, where participants smoked at least once in the past month. Participants included young people from different social contexts, where they varied in age, gender (54 males, 37 females), ethnicity, and education level. The researchers noted that they used the TTI as the theoretical foundation as it provided actionable information for initiatives to prevent smoking in young people, which includes their perspectives as well as its

emphasis on an inclusive approach that does not stigmatize those who smoke. Findings indicated that many personal, social, and familial influences affected young people's smoking behaviors. For young people who smoked, the immediate social environment, which included their family and peers, and risk and benefit ratio contributed to their smoking initiation and maintenance. Smoking-related policies were found to be a distant influence on their smoking behavior. Subramaniam et al. explained that despite counter advertising that included graphic images of diseased organs as warning labels on every cigarette pack, participants did not explicitly acknowledge the harms of smoking.

Young people are often faced with unclear choices about risky behaviors, such as smoking, and tobacco industry marketing techniques may affect their judgment and ultimately influence their decisions to smoke (Slater, 2005). Using the TTI, media effects theory, and ecological theories as the conceptual framework, Slater (2005) examined how tobacco marketing practices and state policies were associated with adolescent attitudes, beliefs, and smoking behavior. The researcher used cross-sectional data collected during a 5-year period (1999 through 2003) from a nationally representative sample of eighth-, 10th-, and 12th-grade students and the communities in which they reside. For the 5 years of data, there are a total of 109,308 students (40,256 eighth graders, 34,928 tenth graders, and 34,124 twelfth graders) and 966 community areas (p. 56). The researcher controlled for student grade, gender, race and ethnicity, whether the student lived with both parents, students' income, parents' level of education (college or more), urbanization, and year of data collection. Findings indicated that lower cigarette prices, less self-service placement, increased levels of tobacco store density, and advertising were associated with

more positive attitudes and beliefs about smoking. In addition, lower cigarette prices, self-service placement, higher levels of advertising, and promotions were associated with increased youth smoking behavior. Slater found that although the results varied by attitudinal and behavioral outcome, higher cigarette prices appeared to have the strongest effect on increasing both disapproval and perceived harm, and decreasing both prevalence and consumption.

Background on E-Cigarettes

Chinese Pharmacist Lik invented e-cigarettes in 2003, which have increased in popularity and selection (Martin, 2012; Grana, Benowitz, et al., 2014). As of 2012, there were approximately 2.5 million users and almost 20 million cartridges and 10 million disposables sold each week in the United States (Martin, 2012, p. 131). In 2007, e-cigarettes were introduced to the United States and other countries, many of which have robust tobacco control programs (Zhu et al., 2013). Martin (2012) reported that there are two types of e-cigarettes available to U.S. consumers: one includes a battery, atomizer, and a prefilled nicotine cartridge, which may be flavored or unflavored, while the other consists of rechargeable e-cigarette starter kits. Martin related that the rechargeable e-cigarette starter kits include multiple rechargeable batteries, an atomizer, universal serial bus (USB) and wall chargers, and a pack of prefilled nicotine cartridges.

E-cigarettes are devices that produce an aerosol by heating a liquid that contains a solvent such as vegetable glycerin, propylene glycol, or a mixture of these, one or more flavorings, and nicotine, although the nicotine may not be included (Longo et al., 2016). Vegetable glycerin or glycerol is a clear, odorless liquid that is produced from plant oils,

such as palm oil, soy, or coconut oil (Group, 2015). Propylene glycol is "a syrupy synthetic liquid added to food, cosmetics, and certain medicines to absorb water and help them stay moist" (Maron, 2014, para. 5). Pugh (2012) defined nicotine as "an alkaloid (a substance with a basic charge) contained in the leaves of several species of plants" (para. 1), where the main commercial source of nicotine is extracted from the dried leaves of tobacco plants.

The evaporation of the liquid at the heating element is followed by rapid cooling to form an aerosol, which is different from the combustion of tobacco (Longo et al., 2016). As a result, Longo et al. (2016) noted that the composition of the aerosol from e-cigarettes and the smoke from tobacco is very different. Longo et al. also noted that users inhale or vape e-cigarette aerosol directly through a mouthpiece. The researchers shared that the e-cigarette device includes a battery, a reservoir that holds the liquid, and a vaporization chamber with heating element.

Although the e-cigarette design was first based on the design of conventional cigarettes, the devices have since changed with later devices allowing users to refill a single device with different liquids and modify the heating element (Farsalinos & Polosa, 2014; Longo et al., 2016). Peak serum nicotine concentration occurs within 5 minutes when users inhale aerosol from a nicotine-containing e-cigarette (Hajek et al., 2014; Longo et al., 2016). Long et al. (2016) explained that the rapid systemic delivery, along with the conventional cigarette method of oral inhalation, results in users having similar experiences that are like cigarette smoking, closer than the FDA approved nicotine-replacement therapy.

The tobacco industry has embraced e-cigarettes as a healthier alternative to tobacco smoking, as a useful alternative for quitting smoking and reducing cigarette consumption, and a way to circumvent smoke-free laws by enabling users to smoke anywhere (Grana, Benowitz, et al., 2014). While the industry has spent very little on advertising e-cigarettes, the product has quickly gained notoriety, mainly from free publicity from American celebrities and television talk show hosts, which tout e-cigarettes intuitive appeal and how they can help smokers quit cigarettes (Zhu et al., 2013, p. 2). In 2014, estimated sales from e-cigarettes was nearly $2 billion and e-cigarette sales could ultimately surpass combusted cigarette sales (Amato, Boyle, & Levy, 2016, p. e24).

Although there is a lack of e-cigarette marketing analysis, the Internet has been and continues to be the main channel for marketing e-cigarette products, along with mall kiosks, tobacco outlets, convenience stores, and pharmacies, which all sell e-cigarettes (Grana, & Ling, 2014). Grana and Ling (2014) reported that Lorillard, a large American tobacco company, acquired Blu eCigs in 2013, a major e-cigarette brand, in anticipation of market opportunities. Zhu et al. (2014) related that Lorillard's acquisition of Blu eCigs resulted in national paid advertising campaigns to promote e-cigarettes, which was quickly followed by other tobacco companies such as Altria and RJ Reynolds. The researchers noted that the most well-known e-cigarette brand, NJOY, is not owned by a tobacco company, and major advertising campaigns have been conducted to show the advantage of e-cigarettes over conventional cigarettes.

It is challenging to determine the potential health effects of inhaling e-cigarette aerosol because of the many possible combinations of customizable options, such as "battery power, nicotine concentration, e-liquids, and use behaviors and puff topography" (HHS, 2016, p. 100; c.f., Buettner-Schmidt, Miller, & Balasubramanian, 2016; Dawkins et al. 2016; Goniewicz et al., 2015; Lopez et al., 2016; Seidenberg, Jo, & Ribisl, 2016). There are variations in the amount of nicotine, flavorants, and other e-liquid constituents in e-cigarettes that are available for purchase, and the aerosolized constituents delivered vary by the type and voltage of the e-cigarette device that consumers use (Cobb et al., 2015; HHS, 2016). Researchers who have studied e-cigarette products have found that e-liquids can contain from 0 milligrams/milliliter to 36.6 milligrams/milliliter of nicotine, can be mislabeled, can differ by propylene glycol and vegetable glycerin ratio, and can have one or more of several thousand available flavorants (Goniewicz et al. 2015; Peace et al., 2016; Zhu et al., 2014). Researchers have also found that some liquids that are intended for use in e-cigarettes contain adulterants that are not mentioned on ingredient lists; moreover, under some user conditions, the heating aerosolization process produces added toxicants that may present health risks (Talih et al., 2015; Varlet, Farsalinos, Augsburger, Thomas, & Etter, 2015).

Thus, inhaling e-cigarette vapors has possible adverse health effects, such as nicotine addiction, and developmental effects on the brain from nicotine exposure, which may have implications for cognition, attention, and mood (HHS, 2016). HHS (2016) reported that additional effects include e-cigarette influence initiating or supporting the use of conventional cigarettes and dual use of conventional cigarettes and e-cigarettes;

e-cigarette influence on subsequent illicit drug use; e-cigarette effects on psychosocial health, particularly among youth with one or more comorbid mental health disorders; and battery explosion and accidental overdose of nicotine.

Smoking is attributed to cardiovascular disease, which can cause death, and exposure to nicotine has been identified as a potential initiating factor in the atherogenic process where fatty plaques in the arteries form (Benowitz & Burbank, 2016; HHS, 2014, 2016; Santanam et al., 2012). Acute administration of nicotine causes cardiovascular effects such as increases in heart rate and blood pressure and greater cardiac output, which leads to an increase in myocardial oxygen demand (HHS 2014; Rosenberg, Benowitz, Jacob, & Wilson, 1980). HHS (2016) discussed the use of nicotine and reward seeking behavior. Researchers have found that adolescent and young adult smokers have an increased tendency for risk taking, both generally and in the presence of peers (Cavalca et al. 2013; Galvan et al., 2013; Lejuez, Aklin, Bornovalova, & Moolchan, 2005). Researchers have also found that smoking during early adolescent may be a "gateway" for later substance abuse, with individuals with attention deficit hyperactivity disorder (ADHD) having disproportionately high rates of comorbid substance abuse (Brook, Balka, Ning, & Brook, 2007; Hanna, Yi, Dufour, & Whitmore, 2001; HHS, 2016, p. 106; Kandel, Yamaguchi, & Chen, 1992; Lai, Lai, Page, & McCoy, 2000; Lewinsohn, Rohde, & Brown, 1999; Wagner & Anthony, 2002; Wilens et al., 2008).

Despite the increasing worldwide consumption of e-cigarettes, their safety is still largely unproven, and it is unknown whether these devices cause *in vivo* toxicological effects that could contribute to cancer (Canistro et al., 2017). Canistro et

al. (2017) examined the comutagenic and cancer-initiating effects of e-cigarette vapor in a rat lung model. The researchers found that e-cigarettes have a powerful booster effect on phase-I carcinogen-bioactivating enzymes, including activators of polycyclic aromatic hydrocarbons (PAHs), and increase oxygen free radical production and deoxyribonucleic acid (DNA) oxidation to 8-hydroxy-2′-deoxyguanosine. In addition, the researchers found that e-cigarettes damage DNA, not only at chromosomal level in peripheral blood such as strand breaks in leucocytes and micronuclei formation in reticulocytes, but also at gene level such as point mutations in urine. Findings indicated that exposure to e-cigarettes could endanger human health, especially among younger and more vulnerable consumers.

There are over 466 brands of e-cigarettes, and these may not all contain the same ingredients or the same nicotine dose (Marchese, 2016; Zhu et al., 2014). Although the health effects, including a link to cancer, of conventional cigarettes are well known, less research has been carried out on the adverse effects of e-cigarettes (Marchese, 2016). Marchese (2016) reported that many of the chemicals found in e-cigarettes are cancer-causing, hence, there is reason for concern. E-cigarettes can cause nausea, vomiting headache, dizziness, choking, burn injuries, upper respiratory tract irritation, dry cough, dryness of the eyes and mucous membrane, release of cytokines and proinflammatory mediators, allergic airway inflammation, decreased exhaled nitric oxide synthesis in the lungs, change in bronchial gene expression, and risk of lung cancer (Marchese, 2016; Meo & Al Asiri, 2014). Thus, e-cigarettes can change gene expression similar to

smoking conventional cigarettes, which increases the risk of lung cancer (Marchese, 2016).

E-Cigarette Use and Demographic, Social, and Economic Indicators

In this cross-sectional research study, demographic, social, and economic indicators include sex, age, race and ethnicity, region, education, poverty status, employment status, marital status, number of children in the family or household, and sexual orientation. These demographic, social, and economic indicators are explored in this section.

Sex, age, race, ethnicity, and region. Non-cigarette tobacco product use, such as hookah, cigars, e-cigarettes, and smokeless tobacco, is increasing in the United States, especially among young adults, and the prevalence of e-cigarette use is also highest among young adults (Adkison et al., 2013; Mays et al., 2016; Pearson et al., 2012; Regan et al., 2011). Higham et al. (2016) reported that, in 2016, there were approximately 13 million e-cigarette users worldwide (p. 1). Delnevo et al. (2015) noted that e-cigarette sales have grown significantly and are expected to generate $3.5 billion in sales by 2015 (p. 2). Delnevo et al. (2015) claimed that this growth in sales is due to the increased prevalence of e-cigarette use among both youth and young adults, along with experimenters and individuals with a history of tobacco use.

In some countries such as the United States, Poland, Latvia, Finland, and South Korea, adolescents and adult awareness of e-cigarettes and e-cigarette trial have at least doubled from 2008 to 2012 (Grana, Benowitz, et al., 2014). Grana, Benowitz, et al. (2014) reported that e-cigarette awareness is more prevalent among men in the United

States, but more women tend to try e-cigarettes. Researchers have found that similar percentages (6.2% in 2011 and 7% in 2012) of adults in the United States and European Union have tried e-cigarettes (King et al., 2013 p. 1626; TNS Opinion & Social, 2012, p. 45). Choi and Forster (2014) investigated beliefs predicting subsequent use of e-cigarettes. The researchers used data collected from October 2010 to March 2011 from 1,379 young adults, with an average age of 24.1 years, from the Minnesota Adolescent Community Cohort who reported never using e-cigarettes and completed follow-up data collection from October 2011 to March 2012. At follow-up, the researchers found that that 21.6% of current smokers, 11.9% of former smokers, and 2.9% of nonsmokers reported having ever used e-cigarettes at follow-up (p. 176). Findings indicated that participants who believed that e-cigarettes were helpful with quitting smoking and believed e-cigarettes were less harmful than cigarettes were more likely to experiment with e-cigarettes at follow-up.

In 2014, findings indicated that 12.6% of adults have ever tried an e-cigarette even one time in their lifetimes, but the use tends to differ by sex, age, and race, and Hispanic or Latino origin (Schoenborn & Gindi, 2015, p. 1). Schoenborn and Gindi (2015) found that men (4.1%) were more likely than women (3.4%) to have ever tried an e-cigarette (p. 2). The researchers found that over 20% of adults aged 18 to 24 years of age had ever tried an e-cigarette, and that use declined as age increased (p. 2). Schoenborn and Gindi also found that Native American or Alaska Native adults (20.2%) and Caucasian adults (14.8%) were more likely than Hispanic (8.6%), African Americans (7.1%), and Asian (6.2%) adults to have ever tried e-cigarettes (p. 2). The researchers

found that current e-cigarette use was higher among Native American or Alaska Native adults (10.7%) and Caucasian adults (4.6%) than among Hispanic (2.1%), African Americans (1.8%), and Asian (1.5%) adults (p. 2).

E-cigarette marketing has drastically increased considerably since the product emerged on the U.S. market in 2007 (King, Patel, Nguyen, & Dube, 2015). King et al. (2015) investigated the prevalence, characteristics, and trends in e-cigarette awareness and use among nationally representative samples of U.S. adults during 2010 to 2013. The researchers used data from the 2010 to 2013 HealthStyles survey, where the sample sizes ranged from 2,505 in 2010 to 4,170 in 2012. The researchers assessed "e-cigarette awareness, ever use, and current use (use within the past 30 days) overall and by sex, age, race/ethnicity, education, income, U.S. region, and cigarette smoking status" (p. 219). King et al. found that during 2010 to 2013, there were increases for e-cigarette awareness, ever use, and current use. Findings indicated that awareness increased among all sociodemographic subpopulations during 2010 to 2013, and there was an increase in ever use of e-cigarettes among all sociodemographic groups except those aged 18 to 24 years, Hispanics, those living in the Midwest, and former smokers. The researchers found that during 2010 to 2013, ever use increased among current and former cigarette smokers, but it remained unchanged among never smokers. The researchers concluded that due to the uncertain public health effect of e-cigarettes, there should be continued examination of emerging use patterns, which is essential for public health planning.

Although data on e-cigarette use among adolescents are limited, researchers have found that similar to adults, adolescents show rapid increases in awareness and use in the

United States, Poland, Latvia, Finland, and South Korea, with higher rates of trial and current use in European countries than the United States or South Korea (CDC, 2013; Goniewicz & Zielinska-Danch, 2012; Grana, Benowitz, et al., 2014; Lee et al., 2013). Youth ever use of e-cigarettes in South Korea increased from 0.5% in 2008 to 9.4% in 2011 (Lee et al., 2013, p. 686), and it increased in the United States from 3.3% in 2011 to 6.8% in 2012 (CDC, 2013, p. 729).

Similar to adults, e-cigarette use is most appealing and prevalent among youth who are also experimenting with or are current tobacco cigarette users (Grana, Benowitz, et al., 2014). There has been a rapid market penetration of e-cigarettes among youth, with trial among U.S. high school students at 10% in 2012 (CDC, 2013, p. 729), which is even higher than the 2011 rate for adults at 6.2% (King et al., 2013, p. 1625). The Utah Department of Health (UDOH, 2013) reported significant declines in cigarette smoking among youth in Utah, but as smoking rates decreased, a number of new tobacco and nicotine products, such as e-cigarettes, have appeared in U.S. markets. The UDOH discussed a public health priority to monitor the increase use of new tobacco products among youth due to safety concerns, candy-like flavors, and large-scale marketing campaigns. The UDOH related that Utah's largest school health and risk behavior survey, the Prevention Needs Assessment (PNA), is conducted in Utah schools in odd years with a sample of more than 50,000 students in grades 6, 8, 10, and 12. The UDOH found that the percentage of Utah students in grades 8, 10, and 12 who reported that they had tried electronic cigarettes more than doubled from 2011 to 2013 and current use tripled from 2011 to 2013. The UDOH noted that despite minors not having legal access

to e-cigarettes, Utah youth are 3 times more likely to report current use than adults. The UDOH found that approximately one-third of Utah youth who used e-cigarettes in the past 30 days report that they never tried conventional cigarettes

Thus, although dual use with cigarettes is high, some youth experimenting with e-cigarettes have never tried conventional cigarettes, which suggests that they may be beginning to use nicotine, an addictive drug, through e-cigarette use (Grana, Benowitz, et al., 2014). The UDOH (2013) found that 31.7% of ever e-cigarette users reported that they had never smoked conventional cigarettes (p. 2). The CDC (2013) found that in 2012, 20.3% of U.S. middle school and 7.2% of U.S. high school ever e-cigarette users reported never smoking conventional cigarettes (p. 729). Lee et al. (2013) found that among South Korean adolescents in 2011, 1.4% of students in grades 7 through 12 who had ever used e-cigarettes had never smoked a conventional cigarette (p. 686). Moreover, Lee et al. found that 9.4% of South Korean adolescents have tried e-cigarettes and 4.7% were current e-cigarette users (p. 686). Lee et al. also found that e-cigarette use was significantly higher for boys (7.8%) than girls for girls (1.8%), older students, larger weekly allowances, and those who did not participate in school-based smoking prevention programs in the past 12 months (p. 685).

In November 2013, New York City Mayor Bloomberg signed into law the Tobacco 21 bill, which imposed the strictest age restrictions on tobacco sales, to include e-cigarettes ((Winickoff, Gottlieb, & Mello, 2014). Winickoff et al. (2014) reported that based on the bill, which became effective May 2014, individuals had to be at least 21 years of age to buy tobacco products. The researchers noted that seven Massachusetts

towns and one Hawaiian county adopted the Tobacco 21 bill law in 2013. In addition, Utah, New Jersey, and New York have introduced similar legislation. Winickoff et al. (2014) claimed that dissemination of the Tobacco 21 law is an important opportunity to decrease smoking, which is one of the most important health risks in the United States.

Education, poverty, employment, marriage, and household size. Due to smoking being very harmful, differences in smoking prevalence across the population translate into major differences in mortality and morbidity rates (Milcarz et al., 2017). Milcarz et al. (2017) examined the prevalence and tobacco use patterns in an adult population of social assistance beneficiaries and their interest in quitting. The researchers conducted a cross-sectional study between October 2015 and February 2016 among a group of male and female adults aged 18 to 59 who resided in a district in Poland and received aid offered by the local social assistance organizations. The questions in the survey covered many important issues such as current smoking, the use of e-cigarettes, physical activity, dietary habits, and alcohol consumption among adults, which were adapted from the Multi-Centre National Population Health Examination Survey (WOBASZ). The researchers also collected data on gender, age, marital status, education, employment, subjective assessment of monthly income, subjective assessment of health condition, declared health problems, and alcohol consumption. Findings indicated that 37.1% of participants, including 52.8% men and 29.6% women, were current smokers (p. 131). The researchers found that over one-third of the smoking participants were willing to quit. Findings also indicated that male gender, lower educational attainment, unemployment or temporary employment, lack of awareness of

smoking-associated health risks, e-cigarette use, and exposure to environmental tobacco smoke were significantly associated with current daily smoking. Milcarz et al. also found that daily smokers' intention to quit smoking "was positively correlated with their awareness of smoking-associated health risks, lack of previous quit attempts, and low exposure to" (p. 131) environmental tobacco smoke. Findings also indicated that smoking prevalence among social assistance recipients is often higher when compared to the general population, but more than half of the smokers were willing to quit. Milcarz et al. emphasized an urgency to develop policies that are tailored to the needs of these disadvantaged population groups.

While cigarette smoking among workers in the United States has decreased markedly, the use of e-cigarettes continues to increase across the United States. This poses tough questions for regulators, health experts, and employers on controlling the use of e-cigarettes in public spaces and workplaces (Lally, 2017; para. 1). Lally reported that 37 states as well as the District of Columbia have prohibited smoking in most workplaces, but only a handful of states have specifically addressed the issue of smoking e-cigarettes in the workplace. Lally noted that six states, including Arkansas, Delaware, New Jersey, North Dakota, Oregon, and Utah, have added e-cigarettes to their indoor smoking regulations. Moreover, a growing number of cities and localities such as Chicago, Los Angeles, and New York City are enacting bans on vaping in public places where traditional cigarettes are prohibited. Berman-Gorvine (2014) noted that research is lacking on how widespread e-cigarette use is in the workplace.

In regard to marriage, married couples tend to share similar health-related characteristics and behaviors such as cigarette smoking status (Roberts, Banse, Ebbeler, & Ferketicha, 2017). Roberts et al. (2017) noted that research that focuses on spousal concordance (SC) patterns for alternative tobacco products, such as e-cigarettes, cigars, and hookah, is lacking. As a result, the researchers examined the roles of age, gender, and culture in the strength of SC for these alternative tobacco products. Participants included 300 married individuals in Columbus, Ohio; however, only 278 participants' data were included in the analysis due to missing data. Using the same survey as the U.S. sample, the researchers also examined SC patterns in Austria, Greece, Israel, the Netherlands, and Slovakia. All participants completed a survey in which they indicated both their own, and their spouse's ever-use of various tobacco products. Findings indicated that for the U.S. participants, SC was highest for e-cigarettes, flavored e-cigarettes, flavored cigarettes, and hookah and also stronger among younger couples, with only a small female to male use difference. While Roberts et al. found similar patterns in the other countries, they noted lower SC for e-cigarettes and flavored e-cigarettes, where e-cigarettes had been federally regulated when the data were collection. The researchers suggested that their findings have implications due to the continued popularity of alternative tobacco use behaviors.

In relation to household size, King et al. (2013) assessed the prevalence and correlates of awareness and ever-use of e-cigarettes among U.S. adults, 18 years and older, during 2010 to 2011. The researchers used stratified random sampling by household size, region, household income, population density, and age select a nationally

representative sample. Findings indicated that in 2010, overall awareness of e-cigarettes was 38.5% among respondents completing the survey by mail and 40.9% among respondents completing the survey by internet; in 2011, awareness was 57.9% among internet survey respondents. Findings also indicated that 2.1% of respondents completing the 2010 mail survey had ever used an e-cigarette, compared with 3.3% of respondents completing the 2010 internet survey and 6.2% of respondents completing the 2011 internet survey. Despite the survey method or year, findings indicated that ever-use of e-cigarettes was significantly higher among current smokers when both former and never-smokers were compared. The researchers also found that during 2010 to 2011, ever-use increased among both sexes, those aged 45 to 54 years, Caucasians, those living in the South, and current and former smokers. King et al. noted the importance of continued investigation into e-cigarettes use for public health planning.

Sexual orientation. The increase in e-cigarette use has also led to increased use among other groups, including sexual minority populations such as lesbian, gay, and bisexual individuals, and gender minority such as transgender individuals, who are collectively part of the lesbian, gay, bisexual, and transgender (LGBT) community (Johnson et al., 2016). Johnson et al. (2016) noted higher rates of tobacco use among sexual minority populations in comparison to nonminority or straight populations. The researchers examined tobacco use by different sexual identities and gender to understand patterns of cigarette smoking and smoking history; and use of other tobacco products including cigars, pipes, hookah, e-cigarettes, and smokeless tobacco. Johnson et al. used data from the 2012 to 2013 National Adult Tobacco Survey of U.S. adults aged 18 years

and older. The researchers created a sexual minority category by combining gay, lesbian, and bisexual responses, along with those who selected an option for other non-heterosexual identities.

Findings indicated higher smoking prevalence among sexual minority adults (27.4%) than straight adults (17.3%; Johnson et al., 2016, p. e91). Johnson et al. (2016) found that bisexual women (36%) had an especially high cigarette smoking rate. Compared to their straight peers, sexual minority women started smoking and transitioned to daily smoking earlier. Results showed that other tobacco product use was higher among sexual minority women, such as e-cigarette (12.4%), hookah (10.3%), and cigar use (7.2%), which was more than triple that of their straight female peers (3.4%, 2.5%, and 1.3%, respectively; p. e91). Similarly, sexual minority men's e-cigarette (7.9%) and hookah (12.8%) use exceeded that of their straight counterparts (4.7% and 4.5%, respectively; p. e91). Overall, findings indicated that tobacco use was significantly higher among sexual minority than straight adults, especially among sexual minority women. Johnson et al. noted that their findings highlighted the importance of tobacco control efforts designed to reach sexual minorities and highlight tobacco use differences within this population.

E-Cigarette Use and Health Characteristic and Behavior Indicators

In this cross-sectional research study, health characteristic indicators include self-reported health status, functional limitations or disabilities, serious psychological distress, and asthma, while health behavior indicators include alcohol drinking status, meeting the

2008 federal physical activity guidelines through LTPA, BMI, and smoking status. These indicators are explored in this section.

Health status and functional limitations.

In regard to functional limitations, Callahan-Lyon (2014) reviewed published data on the human health effects of exposure to e-cigarettes and their components. Callahan-Lyon conducted literature searches through September 2013 and analyzed 44 articles. The researcher found that there may be a possible association between aerosol exposure and respiratory function impairment. Callahan-Lyon concluded that while e-cigarette aerosol may contain fewer toxicants than cigarette smoke, findings are inconclusive on whether e-cigarettes are less harmful than cigarettes and the health effect of e-cigarettes for users and the public cannot be determined with currently available data.

Serious psychological distress. Individuals who have mental illness (MI) are at great "risk for cigarette-related health outcomes because they have higher rates of having ever-smoked cigarettes, smoked more cigarettes per day, have higher rates of nicotine dependency, and suffer more smoke-related morbidity and mortality than people without MI" (Forman-Hoffman et al., 2016, p. 447). Due to these problems, smoking prevention and cessation among individuals with MI, especially for those with serious MI (SMI), has become a national priority (Forman-Hoffman et al., 2016; HHS, 2014). Although smoking prevalence in the overall population has decreased, the smoking prevalence for individuals with MI has not decreased (Center for Behavioral Health Statistics and Quality [CBHSQ], 2013; CDC, 2011; Forman-Hoffman et al., 2016). In addition, researchers noted that people with MI are less likely to quit smoking than those without

MI (El-Guebaly, Cathcart, Currie, Brown, & Gloster, 2002; Forman-Hoffman et al., 2016; Glasheen, Hedden, Forman-Hoffman, & Colpe, 2014; Hitsman, Moss, Montoya, & George, 2009; Mackowick, Lynch, Weinberger, & George, 2012). Prochaska and Grana (2014) reported that most smokers with SMI want to quit, and tobacco treatment trials have demonstrated treatment efficacy in samples of smokers diagnosed with major depression, posttraumatic stress disorder, schizophrenia, and alcohol or illicit drug use disorders.

Approximately 75% of individuals with SMI smoke and most are highly dependent on nicotine, consuming more cigarettes each day than smokers without mental illness (Pratt et al., 2016, p. 30). Pratt et al. (2016) assessed the appeal of e-cigarettes over 4 weeks among 21 chronic smokers with a schizophrenia spectrum disorder or bipolar disorder who had failed a quit attempt and were not engaged in cessation treatment. Research staff provided e-cigarettes and instructions on how to use them and assessed participants weekly for 4 weeks. Findings indicated that 19 of the enrolled participants completed weekly assessments. Use of e-cigarettes did not escalate over the 4 weeks. In addition, findings indicated that 58% of the participants reported temporary and mild side effects such as dry/sore throat, nausea, dizziness, and cough. End of trial ratings of enjoyment, satisfaction compared to regular cigarettes, and willingness to buy e-cigarettes were high (ranging from 3.82 – 4.51 on a 5-point scale). Results of this study suggested that people with SMI may find e-cigarettes an appealing substitute for tobacco cigarettes. These researchers did not find evidence of increasing nicotine dependence

and recommended further randomized studies to better assess e-cigarette appeal and toxicity.

Asthma. E-cigarettes are marketed as safer alternatives to tobacco cigarettes (Polosa et al., 2014), which thus suggests that adults with asthma might try them as a safe alternative to tobacco cigarettes. The prevalence of youth e-cigarette use has increased dramatically, but research is sparse on e-cigarette use among youth with asthma and metropolitan differences (Choi & Bernat, 2016). Choi and Bernat (2016) investigated the prevalence of e-cigarette use among youths with asthma compared with youths without asthma; the association between asthma status and e-cigarette by metropolitan status; and the associations between e-cigarette use, susceptibility to cigarette smoking, and asthma attacks. Participants were high school student (36,085) who took part in the 2012 Florida Youth Tobacco Survey. Findings indicated that the prevalence of ever and past 30-day e-cigarette use among students who reported having asthma were 10.4% and 5.3%, respectively, which was higher than those without asthma (7.2% and 2.5%, respectively, p. 446). Choi and Bernat found that e-cigarette use was more common among students with asthma in nonmetropolitan and rural counties than their counterparts in metropolitan counties. Results showed that ever and past 30-day e-cigarette use was associated with cigarette smoking susceptibility among students with asthma and students who never tried cigarettes. The researchers also found that past 30-day e-cigarette use was associated with having an asthma attack in the past year among participants with asthma. The researchers concluded that Florida high school youth with asthma were more likely than youth without asthma to use e-cigarettes. Furthermore, e-cigarette use among youth

with asthma was associated with susceptibility to cigarette smoking and asthma attacks. The researchers recommended educating youth with asthma about the potential risks related to e-cigarette as part of a larger educational campaign on the potential risks of e-cigarette use.

Alcohol drinking status. Research is limited on the co-occurrence of e-cigarette use and other risk behaviors in adolescents and young adults (HHS, 2016). HHS (2016) reported that e-cigarette use is associated with other tobacco products as well as alcohol and other substance use, such as marijuana. HHS related that nearly all currently available studies on this topic focus on regional, international, and at-risk samples; thus, the conclusions from most studies cannot be generalized to the overall U.S. population. However, in the United States, Cohn et al. (2016) conducted a nationally representative study that examined the associations between e-cigarettes, alcohol, and other drug use in young adults, aged 18 to 24 years. The researchers obtained data from a subgroup of 18 to 24-year-old adults (n = 1609) participating in Wave 4 of the Legacy Young Adult Cohort, a nationally-representative sample of men and women aged 18 to 34 (n = 4288) drawn from the GfK Knowledge Panel (p. 80). Findings indicated that over half of the sample used alcohol every day or some days, while 14% reported that they currently used marijuana (p. 85). Findings indicated that there was a strong correlation between alcohol and marijuana use with cigarette use, and that alcohol use was also strongly correlated with hookah and e-cigarette use in the past 30 days. Littlefield, Gottlieb, Cohen, & Trotter (2015) examined the prevalence rates of current e-cigarette use among college students 17 to 25 years of age in 2014, looking at the association between e-cigarette use

and gender, race and ethnicity, and heavy drinking. They also investigated differences among groups based on the nicotine delivery methods used among college students. Approximately 29% of students reported ever using e-cigarettes, with approximately 14% reporting use in the past 30 days (p. 527). Littlefield et al. found that rates of heavy drinking were 32% for noncurrent nicotine users, 75% for traditional smokers only, 66% for e-cigarette users only, and 67% for dual users (p. 526). Thus, findings indicated an association between e-cigarette use and heavy drinking. The researchers noted that even though there may be harm reduction benefits associated with e-cigarettes, the findings in the study raises concerns about e-cigarette use among college students; thus, additional studies should be conducted in this subpopulation. Other researches have looked at e-cigarette use among college students and reported similar findings. Saddleson et al. (2015) measured prevalence and correlates of e-cigarette use among college students who attended four colleges and universities in Upstate New York in 2013. Participants completed a 111-item, self-administered, web-based survey, which used items from published studies on e-cigarettes, assessed awareness, ever/past and current use within the past 30-days. Findings indicated that 95.5% of participants reported awareness of e-cigarettes, 29.9% were ever users, and 14.9% were current users (p. 25). The researchers found that younger students, males, Caucasians, participants who reported average and below average school ability, ever smokers of or experimenters with tobacco cigarettes, and those with lower perceptions of harm regarding e-cigarettes had higher odds of ever or currently using e-cigarettes. Findings also indicated that risky behaviors, such as tobacco and marijuana or alcohol use, were associated with e-cigarette use. Results also

showed that among never e-cigarette users, students involved in risky behaviors or those who had lower harm perceptions for e-cigarettes, were more susceptible to future e-cigarette use.

Leisure-time physical activity. To further understand the application of e-cigarettes to smoking cessation or tobacco harm reduction, further examination of when and why dual users use cigarettes versus e-cigarettes is important (Pokhrel, Herzog, Muranaka, Regmi, & Fagan; 2015). Pokhrel et al. (2015) examined the contexts of cigarette versus e-cigarette use among dual users. The researchers conducted 12 focus groups with 62 young adult current daily e-cigarette users who concurrently smoked cigarettes or had been recent dual users. Results indicated two activities that participants identified as being conducive to e-cigarette use as opposed to cigarette smoking, which were before or during work-out and physical activity and when working. Pokhrel et al. reported that participants agreed that e-cigarette use was more conducive to physical activity because e-cigarette did not affect their ability to perform during or before physical activity, unlike cigarette smoking that made them feel "drained-out," weak, and negatively affected their breathing (p. 864). In addition, participants shared that it more convenient to use e-cigarettes while working because they did not have to take breaks to smoke and coworkers were more tolerant of their using e-cigarettes as they worked, unlike cigarette use.

Body mass index. Researchers have conducted cross-sectional and longitudinal studies and have found that higher weight status or obesity is linked to problematic tobacco cigarette smoking (Caria, Bellocco, Zambon, Horton, & Galanti, 2009; Cawley,

Markowitz, & Tauras, 2004; Dhariwal, Rasmussen, & Holstein, 2010; Farhat, Iannotti, & Simons-Morton, 2010; Huang, Lanza, Wright-Volel, & Anglin, 2013; Hussaini, Nicholson, Shera, Stettler, & Kinsman, 2011; Lanza, Grella, & Chung, 2014). Accordingly, Lanza, Pittman, and Batshoun (2017) assessed whether a similar relationship extended to e-cigarettes by examining weight status as a correlate of substance use patterns, including e-cigarette use. The researchers collected survey data from a convenience sample of 452 undergraduates during the 2015 and 2016 academic years, and identified four substance use classes: (a) high substance use other than cigarettes and alcohol (19%), (b) risky alcohol use (14%), (c) tobacco cigarettes/e-cigarettes (17%), and (d) low substance use (50%; p. 338). Findings indicated that both obesity status and greater deviation from one's group BMI norm were associated with a higher likelihood of belonging to the cigarette/electronic tobacco use class. Lanza et al. noted that findings suggested that higher weight status and tobacco use may also be associated with e-cigarette use. Hence, these researchers suggested that future studies investigate the longitudinal processes and pathways that underlie the relationship between weight status and e-cigarette use.

Smoking status and smoking cessation. The most common reasons people give for trying e-cigarettes are for use in places where smoking is restricted, to cut down on smoking, and for help with quitting smoking, which is consistent with marketing messages (Dockrell et al., 2013; Douptcheva, Gmel, Studer, Deline, & Etter., 2013; Etter & Bullen, 2011; Goniewicz, Lingas, & Hajek, 2013; Kralikova, Novak, West, Kmetova, & Hajek, 2013). Due to ongoing declines in conventional cigarette smoking prevalence,

Schoenborn and Gindi (2015) examined the extent to which e-cigarettes are being used among U.S. adults, provided the first estimates of e-cigarette use among U.S. adults from a nationally representative household interview survey by selected demographic and cigarette smoking characteristics. The researchers found that current cigarette smokers and recent former smokers who quit smoking in the past 12 months were more likely to use e-cigarettes than long-term former smokers who quit smoker more than 12 months ago and adults who had never smoked. Schoenborn and Gindi found that 47.6% of current cigarette smokers and 55.4% of recent former cigarette smokers had ever tried an e-cigarette (p. 3). In comparison, the researchers found that 8.9% of long-term former smokers and 3.2% of adults who had never smoked cigarettes had ever tried an e-cigarette (p. 3). Findings indicated that approximately 1 in 6 (1.9%) current cigarette smokers and about 1 in 4 (22%) recent former cigarette smokers currently used e-cigarettes, compared with 2.3% of long-term former cigarette smokers and 0.4% of adults who had never smoked cigarettes.

In addition, Schoenborn and Gindi (2015) found that current cigarette smokers who had tried to quit smoking in the past 12 months were more likely (55.3%) than smokers who had not tried to quit (40.2%) to have ever tried an e-cigarette (p. 4). The researchers found that current cigarette smokers who had tried to quit in the past 12 months (20.3%) were about twice as likely as cigarette smokers who had not tried to quit (11.8%) to currently use e-cigarettes (p. 4). Findings also indicated that among adults who had never smoked cigarettes, the percentage who had ever tried an e-cigarette at least one time was highest among individuals aged 18 to 24 years of age (9.7%) and

declined as age increased, to 3.5% among those aged 25 to 44, to 1.2% among those aged 45 to 64, and to 0.2% among those aged 65 and over (p. 5). Thus, Schoenborn and Gindi found that among adults aged 45 and over who had never smoked cigarettes, fewer than 1% had ever tried an e-cigarette even once (p. 5).

Researchers have found that among adults, current smokers have the highest rate of e-cigarette use, followed by former smokers (Adkison et al., 2013; Dockrell et al., 2013; Grana, Benowitz, et al., 2014; King et al., 2013). Etter and Bullen (2014) assessed behavior change over 1 year in users of e-cigarettes by following up on a sample of e-cigarette users recruited from websites that focus on e-cigarettes and smoking cessation. Findings indicated that most (72%) were former smokers at baseline (p. 491). The researchers found that at the 12 month follow up, 6% of former smokers who were daily e-cigarette users at baseline relapsed to smoking cigarettes, and 92% of the former smokers using e-cigarettes daily at baseline were still using e-cigarettes daily at follow-up (p. 493). Etter and Bullen found that among 36 dual users at baseline, 16 (44%) had stopped smoking after 12 months. Findings from epidemiological, population-based studies indicated that across countries, e-cigarettes are most commonly being used concurrently with conventional tobacco cigarettes (Etter & Bullen, 2014; Grana, Benowitz, et al., 2014).

The U.S. Public Health Service (2008) did not include or recommend e-cigarettes as a smoking cessation method. Popova and Ling (2013) examined alternative tobacco product use among smokers, to include e-cigarettes, loose leaf, moist snuff, and dissolvable substances, and the relationship with quit attempts and intentions among a

cross-sectional survey of 1,836 current or recently former adult smokers. Findings indicated that 38% of smokers had tried an alternative tobacco product, most often e-cigarettes (p. 923). In addition, the researchers found that there was a relationship between alternative tobacco product use with having a quit attempt. Thus, individuals who intended to quit were significantly more likely to have tried and to currently use alternative tobacco products than smokers who did not intend to quit. Findings indicated that alternative tobacco product use was not associated with successful quit attempts. Popova and Ling found that participants' interest in alternative tobacco product future use was low except for e-cigarettes.

Findings are mixed as to whether e-cigarettes can be used as a smoking cessation aid. Some researchers have found that there is no conclusive scientific evidence that e-cigarettes promote long-term smoking cessation (Etter et al.; 2011; Kalkhoran & Glantz, 2016). Kalkhoran and Glantz (2016) assessed the associated between e-cigarette use and cigarette smoking cessation among adult cigarette smokers. The researchers searched PubMed and Web of Science databases between April 2015 and June 2015. Kalkhoran and Glantz identified 577 studies but included 38 studies in the systematic review. The researchers found that based in the current use of e-cigarettes, they are associated with significantly less quitting among smokers.

In contrast, some researchers have found that e-cigarettes can aid smoking cessation (Brown, Beard, Kotz, Michie, & West, 2014). Brown et al. (2014) investigated how effective e-cigarettes are compared with nicotine replacement therapy bought over-the-counter and unaided quitting in the general population of smokers who were

attempting to stop smoking. The researchers used cross-sectional household surveys of representative samples of the population of adults in England, which was conducted monthly between July 2009 and February 2014. To examine the comparative real-world effectiveness of e-cigarettes, the researchers compared the self-reported abstinence rates of smokers in the general population trying to stop who used e-cigarettes only without also using face-to-face behavioral support or any medically licensed pharmacological cessation aid with those who used nicotine replacement therapy bought over-the-counter only or who made an unaided attempt, while adjusting many key potential confounders. Findings indicated that participants who reported having used an e-cigarette in their most recent quit attempt were more likely to report still not smoking than those who used nicotine replacement therapy bought over-the-counter or nothing. The researchers noted that this difference remained after they adjusted "for time since the quit attempt started, year of the survey, age, gender, social grade, abrupt versus gradual quitting, prior quit attempts in the same year and a measure of nicotine dependence" (p. 1536).

Researchers have noted that e-cigarettes deliver nicotine that can ease tobacco withdrawal; thus, many smokers use e-cigarettes to assist quit attempts (Bullen et al., 2013). Bullen et al. (2013) examined whether e-cigarettes are more effective than nicotine patches with helping smokers to quit. The researchers conducted a randomized-controlled superiority trial in Auckland, New Zealand, between September 6, 2011, and July 5, 2013 with 657 adults 18 years and older, where 289 were randomized to nicotine e-cigarettes, 295 to patches, and 73 to placebo e-cigarettes. Findings indicated that e-cigarettes, with or without nicotine, were modestly effective at helping smokers to quit,

with similar achievement of abstinence as with nicotine patches, and few adverse events. However, Bullen et al. emphasized that uncertainty exists about the place of e-cigarettes in tobacco control, and more research is still needed to clearly establish their overall benefits and harms at both individual and population levels.

Due to e-cigarettes popularity and the ongoing debate about their possible role in smoking cessation, further investigation is needed (Rahman, Ham, Wilson, Mnatzagamian & Worrall-Carter, 2015). Rahman et al. (2015) investigated whether there was a relationship between e-cigarette use with smoking cessation reduction and if there was any difference in efficacy of e-cigarettes without nicotine on smoking cessation. The researchers searched PubMed, Web of Knowledge, and Scopus databases for articles, and did not place a limit on the publication date. Rahman et al. used six studies that had 7,551 participants in their meta-analysis. Findings indicated that e-cigarette use was associated with smoking cessation and reduction. However, the researchers noted that more randomized controlled trials were needed to evaluate e-cigarette effectiveness against other cessation methods.

Summary and Conclusions

Although cigarette smoking has been slowly and steadily declining in the United States, many different alternative tobacco and nicotine delivery products have been gaining popularity, such as e-cigarettes (Schoenborn & Gindi, 2015). E-cigarettes, which are available in various sizes, flavors, and forms, are marketed and often perceived as being relatively safe (Dinaker & O'Connor, 2016; Schoenborn et al., 2015; Zhu et al., 2013). However, e-cigarettes may cause serious potential health problems because of the

chemicals and toxins they contain (Dinakar & O'Connor, 2016). Due to these potential health risks, the FDA (2017) reported that they started regulating e-cigarettes in August 2016.

E-cigarettes have attracted controversy due to insufficient scientific evidence on its safety and efficacy (Grana, Benowitz, et al., 2014; Zhu et al., 2013). While some researchers argued that scientific evidence does not support claims that the use of e-cigarettes can be used for smoking cessation (Etter et al.; 2011; Grana, Benowitz, et al., 2014; Kalkhoran & Glantz, 2016), some researchers have found that e-cigarettes can aid smoking cessation (Brown et al., 2014). It is important to understand the prevalence of e-cigarette usage among U.S. adults and the factors associated with their use. Using Flay and Petraitis' (1994) TTI as the theoretical foundation, a cross-sectional research study was needed that examined the relationship between ever/past and current e-cigarette use and demographic, social, economic, and health characteristic and behavior indicators using the 2014 and 2015 NHIS data. Findings from this study are directed at public health policy makers and experts as sound scientific evidence regarding the risks and dangers associated with e-cigarette use remains badly needed. By better understanding the demographic, social, economic, and health characteristic and behavior indicators associated with current or ever e-cigarette use, healthcare industry experts will be better able to address the emerging public health crisis with appropriate messages aimed at the right target audiences.

Chapter 2 included an introduction; described the method used to search the literature; discussed the theory of triadic influence, which serves as the theoretical

foundation of this study; presented a literature review, which included background on e-cigarettes and summarized previous research on the associations between e-cigarette use and demographic, social, economic, and health characteristics and behavior indicators. In Chapter 3, the design and methods of analysis used for research, including operational definitions, data set descriptions, limitations/delimitations of the data, and protection of human subjects is discuss.

CHAPTER III
METHODOLOGY

Research Design or Method

In this research study, the 2014 and 2015 NHIS is used (see Appendices A, B, and C), a large, multipurpose, cross-sectional household-based health survey produced annually by the National Center for Health Statistics (NCHS). These data and the survey's design were appropriate for this study. To increase statistical power, I combined two years of data to produce a large sample for analysis. As a result, there were over 70,000 respondents, which enabled me to examine the prevalence of ever use and current e-cigarette use by demographic, social, economic, health characteristic and behavior indicators among U.S. adults aged 18 years and older. Thus, prevalence and association patterns of e-cigarette use could be examined in detail.

Each year, NHIS data is collected from roughly 40,000 responding households; thus, the sample sizes are quite large and yield nationally representative estimates for the United States civilian noninstitutionalized population. Among those excluded from the sample are patients in long-term care facilities, persons on active duty with the Armed Forces (although their dependents residing in U.S. households can be included), incarcerated persons, and U.S. nationals living in foreign countries. The primary purpose of the NHIS is to monitor the health of persons residing in the United States across a broad range of health indicators, including selected health conditions (generally chronic), illnesses, injuries, health behaviors, access to and utilization of medical care, and other health topics. Given its large sample size, researchers can use the NHIS data to

categorize and examine health indicators by many demographic and socioeconomic characteristics. NHIS interviews are conducted throughout the year by trained interviewers from the U.S. Census Bureau. Data are collected in person at the respondent's home using computer-assisted personal interviewing, but follow-ups to complete interviews may be conducted over the telephone, if necessary (NCHS, 2016).

The survey consists of both a core set of questions that remain relatively unchanged each year as well as supplemental questions that are not asked every year (NCHS, 2016). The core consists of four main components: (a) household composition section, (b) family core, (c) sample child core (will not be used in this analysis), and (d) sample adult core. The *household composition section* collects basic demographic and relationship information about all household members of all families living in responding households at the time of interview. The *family core*, which is administered separately for each family in the household, collects sociodemographic and basic health information about all family members. One adult member of the family, known as the *family respondent*, answers all family core questions for each family member but other family members can take part in this interview if they are available and interested in participating (NCHS, 2016). The person data file is produced from the family core, and is the source for many demographic indicators in the NHIS as well as for general information regarding health status and disability, access to care, and health insurance; the family data file is the source of income and poverty status information for each family.

The sample adult core obtains additional information from one randomly selected adult (the Sample Adult) in the family. This part of the interview collects more detailed information on the health conditions, functional limitations, health behaviors, access to and use of health care services, and employment characteristics of the sample adult, who responds for himself or herself. In rare instances when the sample adult is mentally or physically incapable of responding, proxy responses are accepted from another family member who is knowledgeable about the sample adult. In 2014 to 2015, roughly 1% of sample adult interviews utilized a proxy respondent. The sample adult core results in the sample adult data file, and the combined 2014 and 2015 NHIS sample adult data files included a total of 70,369 respondents (NCHS, 2015; NCHS, 2016).

In addition to the sample adult core, the 2015 NHIS contains a large Cancer Control Supplement sponsored by NIH's National Cancer Institute, CDC's National Center for Chronic Disease Prevention and Health Promotion, and FDA's Center for Tobacco Products (NCHS, 2016). The supplement consists of six sections covering diet and nutrition, physical activity, tobacco, cancer screening, genetic testing, and family history. These supplemental questions were asked of all sample adult respondents in each family in addition to the annual set of questions in the sample adult core.

Operational Definitions

In this cross-sectional research study, the dependent variables were ever used an e-cigarette even one time and current e-cigarette use among all adults. The corresponding survey questions for both the 2014 and 2015 NHIS were (a) Have you ever used an e-cigarette, even one time and (b) Do you now use e-cigarettes every day, some

days, or not at all? See Appendices A, B, and C for the links to 2014 and 2015 NHIS codebooks (referred to as "variable layout" files on the NCHS website), which show all survey questions and response categories. The independent or explanatory variables described characteristics of sample adults at the time that the interview took place and across three broad categories: (a) demographic, social, and economic measures and (b) health characteristics and (c) health behaviors.

Per Research Questions 1 and 2, the **demographic, social, and economic variables** included sex, age, race and ethnicity, education, marital status, poverty status (i.e., income), employment status, number of children in the family or household, region, and sexual orientation (NCHS, 2015; NCHS, 2016). The year of interview (2014 or 2015) was also treated as an independent variable and included with these indicators. This group of variables corresponds to the ultimate factors in Flay and Petraitis' (1994) theory of triadic influence (TTI). Because they are considered the most distant from the behavior of interest, they are entered first in the models predicting either ever/past or current use of e-cigarettes.

Health characteristics included self-reported health status, serious psychological distress for the past 30 days, any functional limitations (i.e., persons with disabilities), and ever had asthma. Per Flay and Petraitis, these correspond to distal factors in the TTI, and are the second group of variables entered into the models predicting ever/past or current use of e-cigarettes. **Health behaviors** included BMI, alcohol drinking status, meeting the 2008 federal physical activity guidelines through LTPA, and smoking status. Again, per Flay and Petraitis, these are the proximate factors in the TTI, and are thus the

final set of indicators entered into the models predicting ever/past or current e-cigarette use. In addition, because the proximate factors are closest to the outcome – the use of e-cigarettes – they should be among the most predictive variables in the full model. All dependent and independent variables are discussed in greater detail in the data set description section.

Data Set Description

Information on e-cigarette use was obtained from two questions that were first asked in the 2014 sample adult core and then in the 2015 Cancer Control Supplement: (a) Have you ever used an e-cigarette, even one time and (b) do you now use e-cigarettes every day, some days, or not at all (NCHS, 2015, p. 329; NCHS, 2016, p. 92)? The 2014 and 2015 questions used the same wording and response categories; however, their locations in the surveys were different, and this may affect data comparability across the two years to an unknown extent.

In the 2014 NHIS, the e-cigarette questions were in the adult health behaviors (AHB) section of the sample adult core. The AHB section contains questions about health behaviors such as height and weight (to get BMI), alcohol consumption, LTPA, and use of tobacco products, including tobacco cigarettes. Prior to asking the e-cigarette questions, the interviewer read a short introduction to the questions:

> The next questions are about electronic cigarettes, often called e-cigarettes. E-cigarettes look like regular cigarettes, but are battery-powered and produce vapor instead of smoke.
>
> **Question 1. Have you ever used an e-cigarette, even one time?**
>
> Response categories included "Yes," "No," "Refused," and "Don't know."

> Persons who responded affirmatively to the first question were asked a follow-up question:
>
> **Question 2. Do you now use e-cigarettes every day, some days, or not at all?**
>
> In addition to the responses indicated in the question text, respondents could answer "Refused" and "Don't know."

In the 2015 Cancer Control Supplement, the e-cigarette questions were in the tobacco section of the supplement, which obtained more detailed information than the questions in the 2015 AHB section of the sample adult core. Current and former cigarette smokers who were identified through the questions in the AHB section of the Core were asked in the supplement whether they used menthol cigarettes; the number of cigarettes smoked by former smokers; methods used to quit or attempt to quit smoking; and use of noncigarette tobacco products such as cigars and pipes. Current smokers who had not tried to quit in the past year were asked if they had ever tried to quit in their lifetime, and all current cigarette smokers were asked whether they wanted to quit (NCHS, 2016, p. 86). Prior to asking the e-cigarette questions in the cancer supplement (see Appendix C), the interviewer read a longer introduction to the questions (NCHS, 2016, p. 92):

> The next question is about electronic cigarettes or e-cigarettes. You may also know them as vape-pens, hookah-pens, e-hookahs, or e-vaporizers. Some look like cigarettes, and others look like pens or small pipes. These are battery-powered, usually contain liquid nicotine, and produce vapor instead of smoke.
>
> **Question 1. Have you EVER used an e-cigarette EVEN ONE TIME?**
>
> Response categories included "Yes," "No," "Refused," and "Don't know."
>
> Persons who responded affirmatively to the first question were asked a follow-up question:
>
> **Question 2. Do you now use e-cigarettes every day, some days, or not at all?**

> In addition to the responses indicated in the question text, respondents could answer "Refused" and "Don't know."

Thus, while the e-cigarette questions in the 2014 and 2015 NHIS used the same text and response categories, their introductions and locations in their respective questionnaires were different. Specifically, the 2015 Cancer Control Supplement came at the end of the NHIS interview process, at a point when sample adults may be tiring of the interview and more likely to break it off. This is evident in the number of "not ascertained" responses to the "ever used an electronic cigarette" question in the 2015 NHIS data (see Table 1).

Table 1. Unweighted frequencies and weighted percentages for 2014 and 2015 e-cigarette variables in NHIS

2014 NHIS: ever used electronic cigarettes (ECIGEV), asked in Sample Adult Core, AHB section			**2015 NHIS: ever used electronic cigarettes (ECIGEV1), asked in Cancer Control Supplement, NAE section**		
	Frequency (unweighted)	**Percent (weighted)**		**Frequency (unweighted)**	**Percent (weighted)**
1 Yes	4,452	12.6	**1 Yes**	4,319	13.9
2 No	32,069	87.4	**2 No**	27,408	86.1
7 Refused	35		**7 Refused**	52	
8 Not ascertained	133		**8 Not ascertained**	1,884	
9 Don't know	8		**9 Don't know**	9	
2015 NHIS: e-cigarette use: every day/some days/not at all (ECIGED), asked in Sample Adult Core, AHB section			**2015 NHIS: e-cigarette use: every day/some days/not at all (ECIGCUR1), asked in Cancer Control Supplement, NAE section**		
	Frequency (unweighted)	**Percent (weighted)**		**Frequency (unweighted)**	**Percent (weighted)**
1 Every day	384	9.1	**1 Every day**	354	8.8
2 Some days	892	20.6	**2 Some days**	675	16.0
3 Not at all	3,175	70.3	**3 Not at all**	3,287	75.2
7 Refused	0		**7 Refused**	2	
8 Not ascertained	0		**8 Not ascertained**	0	
9 Don't know	1		**9 Don't know**	1	

Note: weighted percentages do not include "refused," "not ascertained," and "don't know" responses.

In 2014, ECIGEV in the sample adult data file had 133 not ascertained responses, which typically result from discontinued interviews, whereas ECIGEV1 in the 2015 Cancer Control Supplement data file had 1,884 such responses (or almost 6% of all

responses). Because the first question determined the universe of respondents for the following question about current e-cigarette use, these not ascertained cases resulted in a loss of data in 2015 relative to 2014. This can be seen in the differences in the unweighted sample counts and weighted percentages of the follow-up variables, ECIGED in 2014 and ECIGCUR1 in 2015: 9.1% of adults were every day e-cigarette users, 20.6% were some day users, and 70.3% did not use them at all in 2014, compared with 8.8%, 16%, and 75.2%, respectively, of sample adults responding to the 2015 cancer supplement. In other words, while the unweighted frequency of ever using an e-cigarette remained about the same across the two survey years (384 in 2014 versus 354 in 2015), almost 6% of the 2015 sample was lost due to missing information. This may explain why there were fewer "some day" e-cigarette users and more "not at all" users in 2015 compared with 2014.

Table 2 shows unweighted sample counts and weighted percentages for ever/past and current e-cigarette use (the dependent variables) from the combined 2014 and 2015 NHIS files. The combined files yielded an initial count of 8,771 adults who had ever used e-cigarettes; nationally, 13.3% of the U.S. population of civilian, noninstitutionalized adults had ever used an e-cigarette in 2014 and 2015. Regarding current usage, 738 sample adults were using e-cigarettes every day, while 1,567 were using them some days, and 65,939 were not using them at all. Nationally, 1.2% of U.S. adults were using them every day, 2.4% were using them some days, and 96.4% were not currently using them. Because the percentages for every day and some day use were so small, these were combined into a single category for the logistic regression analyses.

Note that while the total number of missing cases (the sum of refused, not ascertained, and don't know responses) are shown for the sample, these were not included in the calculation of weighted percentages in this and subsequent tables.

Table 2. Unweighted Frequencies and Weighted Percentages (With Standard Errors) of Dependent Variables, NHIS, 2014 and 2015 combined

Dependent variables	**Unweighted sample frequencies (*n* = 70,369)**	**Weighted % (*SE*)**
Ever used e-cigarette even one time (among all adults)		
Yes	8,771	13.3 (0.21)
No	59,477	86.7 (0.21)
Missing	2,121	
Current e-cigarette use (among all adults)		
Every day	738	1.2 (0.06)
Some days	1,567	2.4 (0.10)
Not at all	65,939	96.4 (0.12)
Missing	4	

Note. SE = standard error.

Weighted percentages of ever/past and current usage of e-cigarettes by year are shown in Figure 1. Ever use of e-cigarettes among adults aged 18 years and older increased from 12.6% in 2014 to 13.9% in 2015. However, there was no significant difference in current e-cigarette use from 2014 to 2015. As a result of these findings, year of interview was included as an independent variable in the logistic regression models (see Table 3).

Figure 1. Weighted percents of ever/past and current use of e-cigarettes among U.S. adults aged 18 years and older, 2014-2015

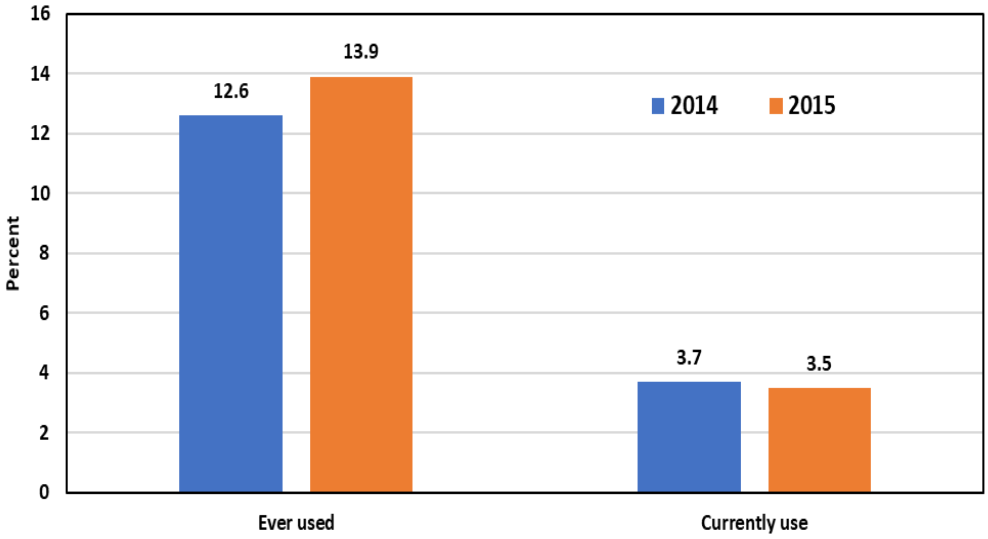


Table 3 shows unweighted sample counts, weighted percentages, and data level (nominal or ordinal) for the independent or explanatory variables that describe characteristics of sample adults at the time that the interview took place and across three broad categories: demographic, social, and economic measures, health characteristics and health behaviors. Demographic, social, and economic variables included sex, age, race and ethnicity, education, marital status, poverty status (i.e., income), employment status, number of children in the family or household, region, and sexual orientation. Most, but not all, of these variables were based on information obtained in either the household composition or the family core components of the interview, where a knowledgeable adult family member responded on behalf of sample adults not taking part in these portions of the interview. However, information on employment status and sexual orientation were obtained directly from sample adults (NCHS, 2015; NCHS, 2016).

Four categories of age were used in the analysis: 18 to 24, 25 to 44, 45 to 64, and 65 years and older, with the youngest age group serving as the reference category. These categories were chosen in order to compare the youngest sample adults (those aged 18 to 24) to older adults in the childbearing (ages 25 to 44), childrearing (ages 45 to 64), and retired (ages 65 and older) periods of their lives. Race and Hispanic ethnicity refer to adults who indicated only a single race group; separate estimates are shown for Hispanics, non-Hispanic Whites (the reference category), non-Hispanic Blacks, non-Hispanic American Indian/Alaska Natives, and non-Hispanic Asians. Adults in other race and ethnicity groups or those who are of multiple race were not included due to small cell counts. The categories of age and race and ethnicity used in this study are identical to those used by Schoenborn and Gindi (2015) in their analysis of e-cigarette use based on the 2014 NHIS. In Table 3, the variables of sex, age, and race and ethnicity do not have any missing cases. Missing information on these variables was imputed by NCHS because these variables were used to create the weight variables on the NHIS data files.

Table 3. Unweighted frequencies and weighted percentages (with standard errors) of adults aged 18 years and older by selected characteristics (explanatory variables), NHIS, 2014-2015

Selected characteristics	Unweighted frequencies (n = 70,369)	Weighted percent (SE*)
Demographic, social and economic indicators		
Year interviewed (nominal)		
2014	36,521	51.2 (0.23)
2015	31,727	48.8 (0.23)
Sex (nominal)		
Male	31,469	48.2 (0.26)
Female	38,900	51.8 (0.26)
Age (ordinal)		
18-24	6,243	12.5 (0.26)
25-44	23,445	34.2 (0.30)
45-64	23,659	34.4 (0.29)
65+	17,022	19.0 (0.26)
Race/ethnicity (nominal)		
Hispanic	11,644	15.7 (0.31)
Non-Hispanic black	9,359	11.9 (0.25)
Non-Hispanic American Indian/Alaska Native	516	0.6 (0.07)
Non-Hispanic Asian	3,907	5.7 (0.14)
Non-Hispanic white	43,634	66.7 (0.40)
Education (ordinal))		
No high school diploma or GED*	10,160	13.0 (0.21)
GED recipient	2,125	2.8 (0.09)
High school diploma	15,725	22.6 (0.25)
Some college, no degree	21,637	30.9 (0.28)
College degree (BA BS, master's, doctorate, professional)	20,411	30.7 (0.36)
Missing	311	
Marital status (nominal)		
Married	30,835	53.06 (0.33)
Divorced/Widowed/Separated	18,773	17.38 (0.21)
Never married	16,310	22.25 (0.28)
Living with partner	4,298	7.30 (0.16)
Missing	153	
Poverty status (ordinal))		
Less than 1.0 (below poverty threshold)	11,219	12.3 (0.23)
1.00-1.99 times poverty threshold	13,930	17.6 (0.24)
2.00-3.99 times poverty threshold	18,877	27.0 (0.30)
4+ times poverty threshold	21,674	35.9 (0.41)
Missing	4,669	7.2 (0.17)
Employment status (ordinal)		
Full-time employment	33,148	50.0 (0.31)
Part-time employment	7,194	11.0 (0.20)
Currently not working	29,463	39.0 (0.31)
Missing	564	

Table 3. continued **Selected characteristics**	**Unweighted frequencies** (n = 70,369)	**Weighted percent (SE*)**
Number of children in family or household (ordinal)		
0 kids	49,297	65.0 (0.32)
1 kid	8,679	14.9 (0.24)
2 kids	7,637	12.7 (0.19)
3+ kids	4,756	7.4 (0.14)
Region (nominal)		
Northeast	11,499	17.4 (0.33)
Midwest	14,911	22.7 (0.41)
South	24,542	37.2 (0.46)
West	19,417	22.7 (0.36)
Sexual orientation (nominal)		
Gay, lesbian, or bisexual	1,705	2.3 (0.08)
Straight	66,036	94.0 (0.13)
Missing	2,628	3.7 (0.11)
Health characteristics		
Self-reported health status (nominal)		
Excellent/very good	40,431	60.7 (0.28)
Good	19,489	26.6 (0.22)
Fair/poor	10,415	12.8 (0.18)
Missing	34	
Serious psychological distress, past 30 days (ordinal)		
Score = 13+	2,467	3.2 (0.10)
Score = 0-12	65,179	92.7 (0.16)
Missing	2,723	4.0 (0.12)
Health characteristics		
Any functional limitations (nominal)		
Yes	26,922	34.5 (0.31)
No	43,352	65.5 (0.31)
Missing	95	
Ever had asthma (nominal		
Yes	9,112	12.7 (0.17)
No	61,196	87.3 (0.17)
Missing	61	
Health behaviors		
Body mass index (ordinal)		
Underweight	1,261	1.8 (0.07)
Healthy weight	22,807	33.1 (0.27)
Overweight	23,235	32.9 (0.25)
Obese	20,595	28.6 (0.27)
Missing	2,471	3.6 (0.10)
Alcohol drinking status (ordinal)		
Lifetime abstainer	14,564	21.0 (0.27)
Former drinker	10,838	14.0 (0.20)
Current infrequent/light drinker	29,715	44.3 (0.29)
Current moderate/heavy drinker	14,019	20.7 (0.25)
Missing	1,233	
Who met the 2008 federal physical activity guidelines (ordinal)		
Met neither physical activity guideline	33,867	47.5 (0.34)
Met one physical activity guideline	21,665	31.6 (0.27)
Met both physical activity guidelines	13,518	20.9 (0.24)
Missing	1,319	

Table 3. continued **Selected characteristics**	**Unweighted frequencies** (n = 70,369)	**Weighted percent (SE*)**
Smoking status (nominal)		
Never smoked	42,185	62.3 (0.27)
Every day smoker, 1 quit attempt lasting at least one day in past year	4,018	5.5 (0.16)
Every day smoker, no quit attempts in past year	4,963	6.7 (0.15)
Some day smoker, 1 quit attempt lasting at least one day in past year	1,726	2.3 (0.08)
Some day smoker, no quit attempts in past year	1,072	1.5 (0.07)
Former smoker, quit within past year	1,059	1.5 (0.06)
Former smoker, quit 1+ year ago	14,867	20.2 (0.22)
Missing	479	

* Notes: SE = standard error; GED = General Educational Development high school equivalency diploma.

In this analysis, education was a five-level categorical variable that indicated highest grade completed or highest degree received at the time of interview: (a) no high school diploma or GED high school equivalency diploma (i.e., respondents who did not complete high school or obtain a GED), (b) GED recipients, (c) high school graduates, (d) some college but no 4-year degree, and (e) bachelor's degree or higher (the reference category). GED recipients and high school graduates were included in separate categories because previous research with NHIS data has shown that these two groups were statistically different from one another with respect to various adult health behaviors, including cigarette smoking (Schoenborn, Adams, & Peregoy, 2013). Because the NHIS did not contain a variable that identified sample adults who were currently enrolled in school, education was shown for all adults even though some may still be continuing their education. Marital status combined divorced, widowed, and separated adults into a single category; and married (the reference category), never married, and cohabiting (living with a partner) adults were in separate categories. Respondents with missing responses (e.g., education, marital status) were not included in the analysis.

The poverty status indicator in Table 3 was based on a grouped recode in the NHIS Family file consisting of 20 categories called RAT_CAT5, which indicated the ratio of the family's income in the previous calendar year to poverty thresholds calculated by the U.S. Census Bureau for the previous calendar year that considered the family's size and the number of children (NCHS, 2016). RAT_CAT5 is collapsed into four categories for this analysis: (a) below the poverty threshold; (b) 1.00 to 1.99 times the poverty threshold; (c) 2.00 to 3.99 times the poverty threshold; and (d) 4 or more times the poverty threshold (the reference category). Because roughly 10% of cases had undefinable or unknown values for this variable, a missing category was included in all logistic regression models.

Employment status distinguished sample adults who were employed full-time (the reference category), employed part-time, or not working. These characteristics reflected the sample adult's employment during the week before the interview; part-time employment consisted of 1 to 35 hours worked that week, and full-time employment consisted of 36 or more hours worked that week. Respondents missing employment status were dropped from the analysis. Number of children in the family or household was based on a recode in the NHIS family file that indicated the number of children under age 18 in the household; if there was more than one family in a particular household, then it indicated the number of children in each family of that household. Region indicated the geographic location of the sample adult's household. The NHIS included a variable on the household file that grouped states and the District of Columbia into four geographic regions:

1. Northeast: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania.

2. Midwest: Ohio, Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska.

3. South: Delaware, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Oklahoma, Arkansas, and Texas.

4. West: Washington, Oregon, California, Nevada, New Mexico, Arizona, Idaho, Utah, Colorado, Montana, Wyoming, Alaska, and Hawaii.

The NHIS added new questions to the 2013 sample adult core regarding sexual orientation. These questions, which had different response categories depending on the respondent's gender, asked all sample adults aged 18 and older, "Which of the following best represents how you think of yourself?" Male respondents could select (a) gay; (b) straight, that is, not gay; (c) bisexual; (d) something else; and (e) I don't know the answer. They could also refuse to answer the question or say that they didn't know. Female respondents could select (a) lesbian or gay; (b) straight, that is, not lesbian or gay; (c) bisexual; (d) something else, and (e) I don't know the answer. They too could refuse to answer or say that they didn't know. This analysis combined "gay", "lesbian or gay", and "bisexual" into a single category, and treated "something else" and "I don't know the answer" as missing information along with any refused, not ascertained, or don't know responses (Ward, Dahlhamer, Galinsky, & Joestl, 2014). These additional difficult-to-interpret response categories increased the overall number of cases with missing information to such an extent that they outnumbered the count of gay, lesbian, and

bisexual respondents. Consequently, these missing cases were retained in the logistic regression analyses as a separate category. Straight or heterosexual adults were the reference category in all models.

Health characteristics were included in this analysis because previous research findings have demonstrated that people with health problems causing or contributing to chronic physical or emotional pain may use legal and illegal substances to self-medicate (Manzella, Maloney, Taylor, 2015; Thornton, Baker, Johnson, & Lewin, 2012; van Hecke, Torrance, Smith, 2013). E-cigarettes may be yet another example of self-medicating behavior, such that being in poor health, disabled, or in psychological distress may promote e-cigarette usage. Accordingly, one such indicator of the sample adult's health was his or her current health status as supplied by the family respondent in the family core interview. The original question asked, "Would you say (the sample adult's) health in general is excellent, very good, good, fair, or poor?" This question did not indicate a reference period and thus reflected health status at the time of interview. For this analysis, excellent and very good were combined in a single category (and served as the reference category) as were fair and poor. Serious psychological distress was based on six questions in the sample adult core that asked respondents how often they felt (a) so sad that nothing could cheer them up, (b) hopeless, (c) worthless, (d) that everything was an effort, (e) nervous, or (f) restless or fidgety, all in the past 30 days. Respondents could choose from five substantive response categories: (a) all of the time, (b) most of the time, (c) some of the time, (d) a little of the time, or (e) none of the time as well as the standard refused and don't know responses (NCHS, 2015; NCHS, 2016). For this analysis, values

of the response categories were reversed so that "all of the time" responses were coded 4, "most of the time" responses were coded 3, "some of the time" responses were coded 2, "a little of the time" responses were coded 1, and "none of the time" responses were coded 0. Refused, not ascertained, and don't know responses to any single question were converted to blanks. Nonblank values were then summed to get a scale with a 0–24 range. A value of 13 or more on this scale was used to define serious psychological distress in the past 30 days, whereas a value of 0–12 indicated no or non-serious psychological distress (Kessler, 2003; Kessler et al., 2003). A total of 2,723 sample adults in the 2014 and 2015 data were missing information on one or more of the source questions and could not be assigned a value on the scale or coded on the psychological distress variable (NCHS, 2015; NCHS, 2016). These cases were retained in the logistic regression analyses in a single missing category. Adults in the non-serious category (a score of 0–12 on the scale) served as the reference category.

Two additional indicators of health status were also included in the analysis, which are now discussed. First, sample adults were asked a series of questions regarding the degree of difficulty they experienced while performing specific tasks without special equipment, such as walking three city blocks; climbing 10 steps without resting; standing for 2 hours; sitting for 2 hours; stooping, bending, or kneeling; reaching over their heads; and grasping or handling small objects. The resulting variables were used to create a summary recode on the sample adult data file called FLA1AR, consisting of three categories: (a) limited in any way, (b) not limited in any way, and (c) unknown if limited. In Table 3, sample adults who were limited or disabled in any way were represented in

the *yes* category while those not limited or disabled were in the *no* category and served as the reference category (NCHS, 2015; NCHS, 2016). Regarding the second indicator, sample adults were also asked if they had ever been told by a doctor or other health professional that they had asthma. This variable was included as an independent variable in the logistic regression analyses to determine if asthmatic adults were more likely to use e-cigarettes as a less harmful smoking option than tobacco cigarettes (Polosa et al., 2014). No other respiratory conditions were included in the analysis because either the NHIS did not ask about "ever" diagnoses (e.g., only information about diagnoses of chronic bronchitis within the past 12 months was obtained) or because the condition is typically diagnosed at older ages (e.g., emphysema). Respondents missing information on health status, functional limitations, and asthma were not included in the analysis.

Independent variables describing health behaviors included BMI; alcohol drinking status; whether the sample adult met the 2008 federal physical activity guidelines through LTPA; and smoking status. It was important to control for these variables because there is a large body of previous research indicating that risk-taking behaviors are associated with one another, particularly among younger persons; that is, if individuals engage in one risk-taking behavior, they are likely to engage in other such behaviors (Hershberger, VanderVeen, Karyadi, & Cyders, 2016; Saddleson et al., 2015). BMI was a recode included on the 2014 and 2015 sample adult data files based on the height and weight reported by the sample adult (in feet/inches and pounds); these values were converted into meters and kilograms, and BMI was calculated from the standard formula (weight / [height]^2). For both men and women, the underweight category included a BMI less than

18.5, healthy weight was BMI 18.5 to less than 25.0 (the reference category), overweight was 25.0 or more to less than 30.0, and obese was 30.0 or more (NCHS, 2015, NCHS, 2016). Extremely high BMI values were not identified on the public use data files for confidentiality reasons, so these were coded to the missing category. Thus, respondents could be missing on BMI because they refused to answer the height and/or weight questions, did not know their height and/or weight, or had an extreme BMI value. Because the percentage of missing cases shown in Table 3 was twice the percentage of underweight respondents (3.6% and 1.8%, respectively), a missing category was retained in the logistic regression analyses.

Alcohol drinking status was based on a recode (ALCSTAT) available in the 2014 and 2015 sample adult data files that was created from sample adults' self-reported responses to a series of questions about alcohol consumption. A lifetime abstainer (the reference category in all models) had fewer than 12 drinks in his or her lifetime. Former drinkers included adults who had not had any drinks in the past year but had 12 or more drinks in their lifetimes. Current infrequent or light drinkers included sample adults who had 12 or more drinks in their lifetimes, and either had 1 to 11 drinks in the past year (i.e., infrequent) or three or fewer drinks per week in the past year (i.e., light). In addition to having 12 or more drinks in their lifetimes, current moderate or heavy drinkers included men who had 3 to 14 drinks per week in the past year or females who had 3 to 7 drinks per week in the past year (i.e., moderate), or more than 14 drinks per week in the past year (men), or more than 7 drinks per week in the past year (women). Current drinkers for whom the frequency of consumption or amount consumed was unknown

were included in the missing category along with sample adults with drinking status unknown (NCHS, 2015; NCHS, 2016), and were omitted from the logistic regression analyses.

Compliance with the 2008 federal physical activity guidelines were measured in a manner consistent with "Summary Health Statistics for U.S. Adults: National Health Interview Survey, 2012," which was the last NCHS Series report summarizing health conditions, behaviors, and access to care among U.S. adults (Blackwell, Lucas, & Clarke, 2014). Measures of physical activity reflected the federal 2008 physical activity guidelines for Americans (Office of Disease Prevention and Health Promotion, 2017). The 2008 federal guidelines recommended that for substantial health benefits, adults should perform at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination. The guidelines also distinguished between aerobic activity, which should be performed in episodes of at least 10 minutes that are preferably spread throughout the week, and muscle-strengthening activities that are of moderate or high intensity, involve all major muscle groups, and are performed 2 or more days per week.

NHIS questions asked about frequency and duration of light-to moderate-intensity and vigorous-intensity leisure-time aerobic activities, and frequency of leisure-time muscle-strengthening activities. These questions were phrased in terms of current behavior and did not refer to a specific time period (for example, activities performed within the past month or year). Responses to these questions were used to identify

sample adults who did not meet either the aerobic or muscle-strengthening guidelines; those who met the aerobic guideline but not the muscle-strengthening guideline, or vice versa; and those who met both the aerobic and muscle-strengthening guidelines (the reference category). Respondents with missing information on physical activities questions were not included in the analysis. Importantly, there is a disconnect between the 2008 federal guidelines, which specified total physical activity performed at any time or for any reason, and the NHIS questions, which asked about physical activity performed during leisure-time. Therefore, the independent variable used in this analysis did not fully capture total physical activity, especially for those adults who perform more physical activity at work, and is best interpreted as an indicator of leisure-time lifestyle choices that may be associated with other lifestyle choices, such as use of e-cigarettes.

Finally, the smoking status variable used in this analysis was created from several recodes in the NHIS sample adult data files that indicated cigarette smoking status (SMKSTAT2), time since former cigarette smokers quit smoking (SMKQTY), and quit attempts lasting more than 1 day within the past year among current cigarette smokers (CIGQTYR). Importantly, these recodes were all based on questions asked in the AHB section of the sample adult cores in both survey years, so relatively large numbers of "not ascertained" responses or item nonresponse (e.g., "refused" and "don't know") were not an issue; consequently, the count of missing cases in the resulting analysis variable was small and were therefore not included in the analysis. For this analysis, sample adults were assigned to one of seven mutually exclusive categories:

1. Never smoked (those who had smoked fewer than 100 cigarettes in their entire life).
2. Every day smokers with one quit attempt lasting at least one day in past year.
3. Every day smokers with no quit attempts in past year.
4. Some day smokers with one quit attempt lasting at least one day in past year.
5. Some day smokers with no quit attempts in past year.
6. Former smokers who quit within past year.
7. Former smokers who quit 1 or more years ago.

Every day smokers with no quit attempts in the past year were assumed to be the most committed smokers, and served as the reference category in the logistic regression analyses. As indicated in Chapter 2, previous research findings indicated that ever/past and current e-cigarette use was more likely among current cigarette smokers. Furthermore, evidence suggested that adults may believe that e-cigarettes are less harmful than tobacco cigarettes, and that using e-cigarettes is a means of reducing use of tobacco cigarettes, or quitting them altogether (Choi & Forster, 2014). This combined smoking status and quit attempt variable thus represented an attempt to detect possible associations in the data that are consistent with these possibilities. However, it is important to point out that the NHIS did not ask sample adults why they were using e-cigarettes, so any statistically significant findings with respect to this variable are suggestive.

Data Analysis

The NHIS is a survey of U.S. households based on a complex multistage sampling design, and appropriate statistical packages must be used to adjust for this complex design to obtain correct, unbiased variance estimates, and standard errors. All estimates (percentages and odds ratios [OR]) reported in the figures and tables produced

by this analysis were calculated using SAS-callable SUDAAN version 11.0.0, a software package recommended by NCHS for analyzing NHIS data (NCHS, 2016). The test statistic that was used to determine if the difference between two percentages is statistically significant was

$$Z = \frac{\left|X_a - X_b\right|}{\sqrt{S_a{}^2 + S_b{}^2}},$$

where X_a and X_b are the two percentages being compared, and S_a and S_b are the SUDAAN-calculated standard errors of those percentages (Blackwell, Lucas, & Clarke, 2014). The critical value that was used for two-sided tests at the 0.05 level of significance was 1.96. Terms such as greater than and less than indicated a statistically significant difference in percentages or OR. Terms such as not significantly different or no difference indicated that no statistically detectable differences were seen between the estimates being compared.

All analyses were based on data from the 2014 and 2015 NHIS (NCHS, 2015; NCHS, 2016), which utilized the same sample design across the two survey years, so no adjustments were needed to the variables in the data files that controlled for design effects. Across these 2 years of data, the average final response rate to the sample adult interviews was 57.8% (NCHS, 2015; NCHS, 2016); this rate does not reflect the response rate to the 2015 Cancer Control Supplement, which NCHS did not report in its annual report summarizing the 2015 NHIS public use data files. Two years of NHIS data were combined to increase reliability of the estimates for some of the smaller population subgroups; this also doubled the sample size of e-cigarette users available for analysis.

Within each survey year, the household, family, person, and sample adult data files (and in 2015, the Cancer Control Supplement) were merged by the appropriate identifiers common across these data files, and then the merged files from 2014 and then 2015 were combined to create a single analysis file. Because the dependent variables were located on the sample adult data files, the sample adult weights were used for all analyses to obtain nationally representative estimates for the civilian noninstitutionalized population of adults aged 18 years and older residing in the United States in 2014 and 2015; these weights were in turn derived from 2010 Census-based population estimates (NCHS, 2016). For this analysis, the weights on the 2014 and 2015 sample adult data files were divided by 2, which is the procedure advised in Appendix IV of the NHIS survey description document when 2 years of data are being combined for an analysis (NCHS, 2016). Respondents with missing data or unknown information on either the dependent or independent variables were excluded from the logistic regression analyses. Most independent variables had percentages missing that were a fraction of a percent, so excluding these cases was not a cause for concern. However, if the percentage of missing cases on any independent variable was large relative to the substantive categories for that variable, these cases were included in the logistic analyses as a separate missing category for that variable. Treiman (2009) maintains that removing too many missing cases may produce results that are not representative of the adult population. Therefore, the variables for poverty status, sexual orientation, serious psychological distress, and BMI each have an additional category indicating missing cases.

Logistic regression is a model of association that is used to determine the probability of an outcome occurring or not occurring, given that other variables that are hypothesized to be related to that outcome have occurred. The outcome being predicted is a dependent variable with two categories, referred to as a dichotomous or binary dependent variable. The linearity assumptions of the ordinary least squares regression model do not hold with a dichotomous dependent variable, so the logistic regression model is used instead (Allison, 2012). In this analysis, the independent variables were also categorical variables, but they were not limited to two categories. One category of each independent variable was designated the reference category, so that the results for each category of a particular independent variable were interpreted relative to the reference category. Independent variables used in a logistic analysis can also be continuous, but the models developed in this study were limited to categorical independent variables. Similarly, logistic regressions are not limited to binary dependent variables; a logistic model predicting an outcome with more than two categories is called a multinomial logistic regression based on a polytomous dependent variable (Allison, 2012).

According to Allison (2012, pp. 15–17), a problem with probabilities is that they are bounded by 0 and 1, but this is not the case for odds, which are related to probabilities and can exceed 1. For this reason, the logistic regression model is based on odds rather than probabilities because odds do not have an upper bound. Furthermore, taking the logarithm of the odds removes the lower bound of zero as well. Setting the log of the odds equal to a linear, or additive, function of the independent variables results in the

logistic model. For k independent variables and i = 1,…, n individuals, the model is represented by the following equation:

$$\text{Log}\left[\frac{p_i}{1-p_i}\right] = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \ldots + \beta_k X_{ik},$$

where β_0 is an intercept term and β_1 through β_k are the regression (or beta) coefficients corresponding with the independent variables X_1 through X_k. The expression on the left side of the equation is referred to as the logit or log-odds (Allison, 2012). Moreover, the β's or beta coefficients produced by the model are exponentiated (e^{β}) and interpreted as OR that describe the effect of a 1-unit change in a particular category of *X* relative to its designated reference category. Sudaan output reports both beta coefficients and OR (the latter were included in the tables, along with confidence intervals at the 0.05 significance level).

Limitations/Delimitations

The NHIS data have several notable strengths. Estimates presented in this analysis are based two years of National Health Interview Survey data collected from nationally representative samples of U.S. households, with each single-family household yielding a randomly selected adult aged 18 years or older. Using two years of combined data yielded a large sample size that provided reliable estimates of e-cigarette use (both "ever" and current), even for smaller population subgroups. Furthermore, given appropriate weighting methodology and the use of statistical software that correctly adjusted for the complex sample design of the NHIS, this analysis produced percentages and odds ratios that are representative of the U.S. civilian, noninstitutionalized adult population.

The survey questions that were the sources of the independent variables used in this analysis did not change across the 2014 and 2015 NHIS, making them comparable and adding to their reliability as predictors. However, the context and location of the questions on ever and current e-cigarette usage – the dependent variables in this analysis – most certainly did change across the two survey years, and in such a way that the number of cases available for analysis was reduced. It is impossible to know how these 1,884 respondents might have answered the questions in the 2015 NHIS on e-cigarette usage. If these individuals opted out of the survey in an unsystematic manner, then the loss of these cases might affect the sample size and ultimately the ability to test for statistically significant differences, likely resulting in somewhat more conservative estimates of current e-cigarette use in 2015 relative to 2014.

While data from the 2016 NHIS were not available when I carried out analysis, it is available now and can be used to determine how samples adults answered the e-cigarette questions in 2016. In the 2016 questionnaire, the follow-up question on current e-cigarette use was moved back into the AHB section of the sample adult questionnaire so that it immediately followed the ever-use question. Thus, the number of missing responses in 2016 was comparable to the number of missing responses in 2014. Data from the 2016 NHIS indicated that the weighted percent of adults not currently using e-cigarettes in 2016 was 79.3%, compared to 70.3% in 2014 and 75.2% in 2015. It thus appears that the increase found in the 2015 data was part of a trend and not a result of the missing cases in the 2015 data, suggesting that respondents opted out of the survey unsystematically.

Other data limitations must also be acknowledged. The focus of this cross-sectional research study was on the relationship between ever/past and current e-cigarette use and demographic, social, economic, health characteristic and health behavior indicators using the 2014 and 2015 NHIS data. Inherent in the nature of secondary analyses of existing data in general, the NHIS data were not collected to address particular research questions or to test particular hypotheses (Cheng & Phillips, 2014). Nevertheless, for the purposes of this cross-sectional research study, the 2014 and 2015 NHIS data were sufficient to answer the study's research questions and hypotheses.

In addition, the NHIS obtains information from most respondents through an in-person interviewing process, with a typical interview averaging about 1 hour. As a result, all NHIS data are based on subjective self-reports. Self-reporting enhances the accuracy of the data to the extent that respondents willingly provide information. However, respondents may provide incorrect information due to recall issues because they did not understand the question or because they have different cultural definitions of some of the concepts used in the survey questions. In addition, as with all surveys, respondents may not answer truthfully regarding some behaviors to avoid embarrassment or to create a favorable impression on the interviewer. Additionally, not all questions in the survey were answered by the sample adult; in fact, much of the demographic information in the family core comes from a knowledgeable family respondent who responds for all family members. Census interviewers have no way of determining the respondent's knowledgeable.

Furthermore, the NHIS is a cross-sectional survey that obtains information about the sample adult at the time of the interview. Little retrospective information is collected from sample adults regarding past health behaviors, conditions, or health status. In particular, no information was obtained regarding how long sample adults have been using e-cigarettes, which particular e-cigarette products they used, or how many times per day or per week they currently used e-cigarettes. Furthermore, sample adults were not asked about their motivations for using e-cigarettes; specifically, whether they were using them in lieu of tobacco cigarettes or to quit smoking tobacco cigarettes altogether. As with any analysis based on cross-sectional data, one can only determine the extent to which selected independent variables are associated with the dependent variables. The directionality of these relationships, and ultimately cause and effect, cannot be established.

Protection of Human Subjects

A Collaborative Institutional Training Initiative (CITI) tutorial was completed (see Appendix D). A cross-sectional research study using data collected by the National Center for Health Statistics in 2014 and 2015 was completed; thus, this study was evaluated and approved under the exempt category as the research presented no risk or less than minimal risk as defined by the federal regulations 46.101(b) due to the use of secondary data (Gentilin & Bright, 2017). This study met the Not Human Research criteria set forth by the Code of Federal Regulations (45CFR46); thus, this project has been deemed not to be human research and was not subjected to oversight by the Medical University of South Carolina's IRB (Federal Wide Assurance # 1888).

CHAPTER IV
RESULTS

In this chapter, a brief introduction, presentations of results and findings from several frequency table analyses followed by multivariate results from two logistic regressions based on the research questions posed in Chapter 1 are presented (and repeated again, below). The purpose of this cross-sectional research study was to examine the relationship between e-cigarette use (ever/past and current) and explanatory variables across three broad categories: (a) demographic, social, and economic measures, (b) health characteristics, and (c) health behaviors. Two research questions were examined. The first research question examined the relationship between ever/past e-cigarette use and demographic, social, economic, health characteristic and behavior indicators. The second research question examined the relationship between current e-cigarette use and these same indicators.

Results/Findings

In this subsection, results from several frequency table analyses, and results from two logistic regression analyses in terms of the research questions posed in Chapter 1 are discuss.

1. **What factors, if any, are related to ever/past e-cigarette use?**

   H_0: There is no significant relationship between ever/past e-cigarette use and demographic, social, and economic indicators.
   H_a: There is a significant relationship between ever/past e-cigarette use and demographic, social, and economic indicators.
   H_0: There is no significant relationship between ever/past e-cigarette use and health characteristic indicators.

H_a: There is a significant relationship between ever/past e-cigarette use and health characteristic indicators.

H_0: There is no significant relationship between ever/past e-cigarette use and health behavior indicators.

H_a: There is a significant relationship between ever/past e-cigarette use and health behavior indicators.

2. What factors, if any, are related to current e-cigarette use?

H_0: There is no significant relationship between current e-cigarette use and demographic, social, and economic indicators.

H_a: There is a significant relationship between current e-cigarette use and demographic, social, and economic indicators.

H_0: There is no significant relationship between current e-cigarette use and health characteristic indicators.

H_a: There is a significant relationship between current e-cigarette use and health characteristic indicators.

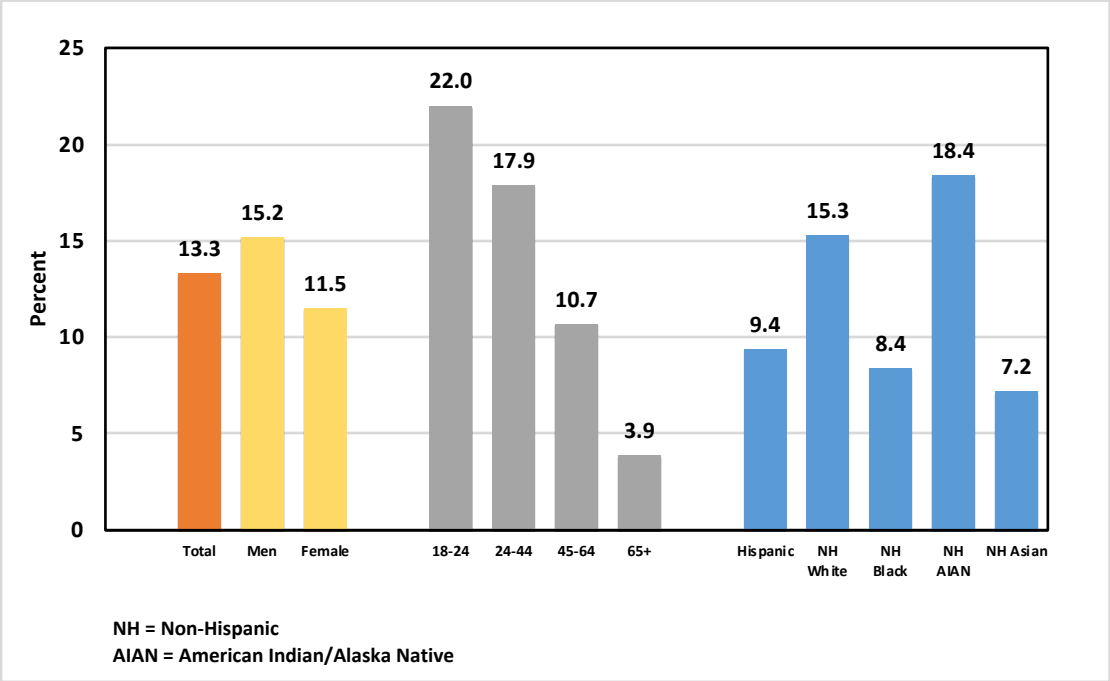
H_0: There is no significant relationship between current e-cigarette use and health behavior indicators.

H_a: There is a significant relationship between current e-cigarette use and health behavior indicators.

Frequency table analyses. Figure 2 shows weighted population percentages for ever/past use of e-cigarettes among U.S. adults aged 18 years and over by sex, age, and race/ethnicity in 2014 and 2015. Overall, 13.3% of U.S. adults reported ever using an e-cigarette, with men being more likely to do so than women (15.2% vs. 11.5%). Over one-fifth (22%) of adults aged 18 to 24 had ever used an e-cigarette compared with 17.9% of adults aged 24 to 44, 10.7% of adults aged 45 to 64, and 3.9% of adults aged 65 and older. Thus, ever/past use of e-cigarettes uniformly declined as age increased. In

addition, non-Hispanic White (15.3%) and non-Hispanic American Indian/Alaska Native (18.4%) adults had comparable percentages of ever using e-cigarettes, and both were more likely to have ever used e-cigarettes than Hispanic (9.4%), non-Hispanic Black (8.4%), and non-Hispanic Asian (7.2%) adults. Hispanic (9.4%) and non-Hispanic Black (8.4%) adults had comparable percentages of ever using e-cigarettes, and both were more likely than non-Hispanic Asian adults to have ever used an e-cigarette.

Figure 2. Weighted percents of ever/past use of e-cigarettes among U.S. adults aged 18 years and older, by selected variables, 2014–2015



The pattern of current e-cigarette use, shown in Figure 3, among all adults was somewhat different relative to Figure 2. Overall, only 3.6% of U.S. adults reported currently using an e-cigarette every day or some days; 4.2% of men were currently using them compared with 3% of women. Percentages of current use among adults aged 18 to 24 (5.1%) and those aged 24 to 44 (4.5%) were not significantly different, adults in these

age groups were more likely to be current users than adults aged 45 to 64 (3.4%) and adults aged 65 and older (1.3%). There was also a statistical difference between adults aged 45 to 64 and those aged 65 and older. Again, non-Hispanic White (4.4%) and non-Hispanic American Indian/Alaska Native (6.8%) adults were more likely to be current users of e-cigarettes than Hispanic (2.1%), non-Hispanic Black (1.9%), and non-Hispanic Asian (1.9%) adults. Hispanic, non-Hispanic Black, and non-Hispanic Asian adults. Adults in the latter three groups all had comparable percentages of current e-cigarette use.

Figure 3. Weighted percents of current use of e-cigarettes among U.S. adults aged 18 years and older, by selected variables, 2014–2015

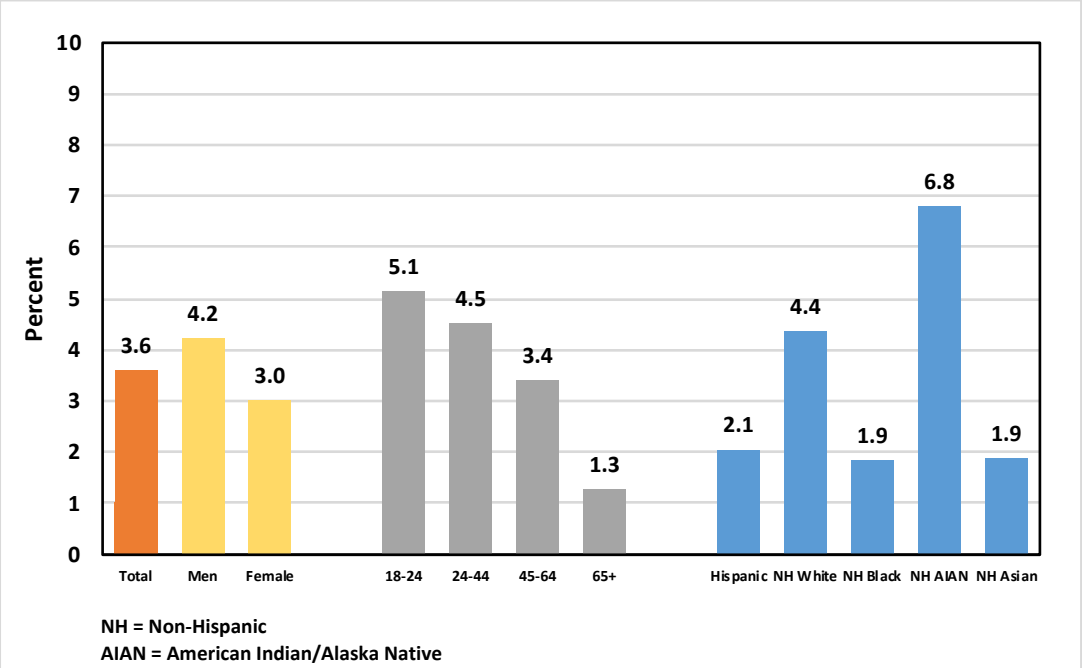
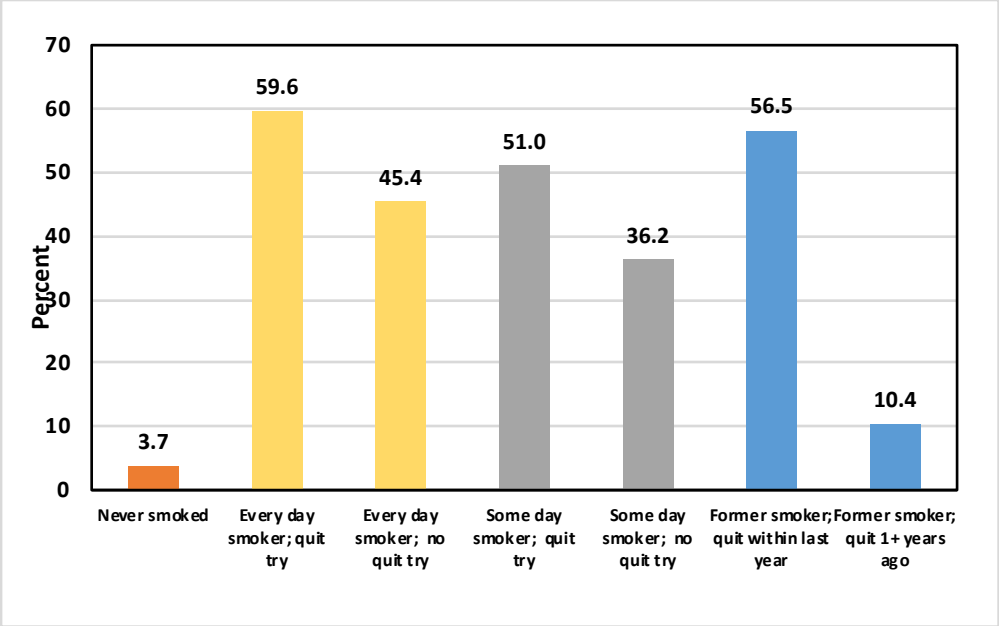


Figure 4. Weighted percents on ever/past use of e-cigarettes among adults aged 18 years and older, by smoking status, 2014–2015



Figures 4 and 5 demonstrate the strong associations between current (tobacco) cigarette smoking status and ever/past and current e-cigarette use previously noted in earlier research. In these figures, smoking status distinguishes between never smokers; current, every day smokers who attempted to quit smoking for at least one day during the past year; current, every day smokers with no quit attempts in the past year; current, some day smokers who attempted to quit smoking for at least one day during the past year; current, some day smokers with no quit attempts in the past year; former smokers who successfully quit smoking within the past year; and former smokers who successfully quit more than one year ago. As depicted in Figure 4, among current every day smokers who had ever used e-cigarettes, 59.6% had one quit attempt lasting for at least one day in the past year compared with 45.4% who had no quit attempts. Similarly, among current

"some day" smokers who had ever used e-cigarettes, 51% had one quit attempt lasting for one day in the past year compared with 36.2% who had no quit attempts in the past year. Moreover, among former smokers who had ever used an e-cigarette, 56.5% had quit smoking cigarettes within the past year compared with 10.4% who had quit one or more years ago. Lastly, 3.7% of adults who had never smoked cigarettes had ever used an e-cigarette.

Figure 5. Weighted percents of current use of e-cigarettes among U.S. adults aged 18 years and older, by smoking status, 2014–2015

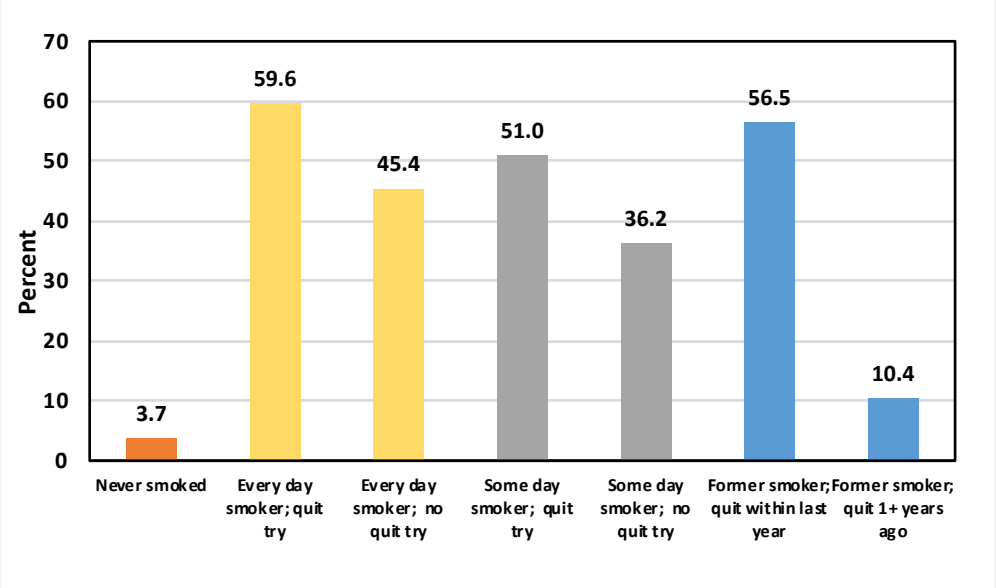


Figure 5 shows the association between current use of e-cigarettes and (tobacco) cigarette smoking status. While these percentages are not of the same magnitude as those in Figure 4, similar conclusions are obtained. Among current every day smokers who were currently using e-cigarettes, 18.5% had one quit attempt lasting at least one day in the past year compared with 11.5% who had no quit attempts. Similarly, among current "some day" smokers who were currently using e-cigarettes, 19.3% had one quit attempt

lasting for one day in the past year compared with 9.2% who had no quit attempts in the past year. Among former smokers who were currently using e-cigarettes, 22.8% had quit smoking cigarettes within the past year compared with 2.9% who had quit one or more years ago. Lastly, only 0.5% of adults who had never smoked cigarettes were currently using e-cigarettes.

Multivariate analysis predicting ever/past use of e-cigarettes

The multivariate logistic regression models were formulated to answer the research questions posed in Chapter 1. Table 4 focuses on Research Question 1 pertaining to ever/past e-cigarette use, and shows OR and 95% confidence intervals (CI) obtained from the first logistic model predicting ever/past use of e-cigarettes. Results are presented for demographic, social, and economic indicators (Column 2, labeled "Demographic Model"); for health characteristics while controlling for demographic, social, and economic indicators (Column 3, labeled "Demographic + Health Characteristic Model"); and for health behaviors while controlling for the demographic, social, economic, and health characteristics (Column 4, labeled "Demographic + Health Characteristics + Health Behaviors Model"). Each model thus builds on the previous model, with Column 4 representing the full model including all independent variables. Statistically significant OR are indicated by asterisks and are in boldface.

Table 4. Adjusted odds ratios and confidence intervals (in parentheses) predicting ever used an e-cigarette, U.S. adults aged 18 years or older; NHIS, 2014-2015

Odds ratio	Demographic Model	Demographic + Health Characteristics Model	Demographic + Health Characteristics + Health Behaviors Model
Year			
2014 (ref)	1.00	1.00	1.00
2015	**1.17* (1.09, 1.26)**	**1.15* (1.07, 1.23)**	**1.37* (1.26, 1.50)**
Sex			
Male	**1.35* (1.25, 1.46)**	**1.41* (1.30, 1.52)**	**1.13* (1.03, 1.24)**
Female (ref)	1.00	1.00	1.00
Age			
18-24 (ref)	1.00	1.00	1.00
25-44	1.11 (0.98, 1.25)	0.98 (0.87, 1.11)	**0.43* (0.36, 0.52)**
45-64	**0.52* (0.45, 0.60)**	**0.41* (0.36, 0.48)**	**0.18* (0.15, 0.21)**
65+	**0.15* (0.12, 0.18)**	**0.12* (0.10, 0.14)**	**0.07* (0.06, 0.09)**
Race/ethnicity			
Hispanic	**0.34* (0.30, 0.37)**	**0.35* (0.31, 0.39)**	0.64* (0.56, 0.73)
Non-Hispanic Black	**0.33* (0.30, 0.37)**	**0.34* (0.30, 0.38)**	0.40* (0.35, 0.45)
Non-Hispanic AIAN	0.73 (0.48, 1.13)	0.68 (0.45, 1.03)	0.66 (0.36, 1.20)
Non-Hispanic Asian	**0.45* (0.39, 0.52)**	**0.48* (0.42, 0.56)**	**0.70* (0.58, 0.86)**
Non-Hispanic White (ref)	1.00	1.00	1.00
Education (5 categories)			
No high school diploma or GED	**2.30* (1.99, 2.66)**	**2.04* (1.76, 2.36)**	1.03 (0.85, 1.25)
GED recipient	**4.68* (3.92, 5.59)**	**4.16* (3.48, 4.98)**	**1.51* (1.19, 1.93)**
High school diploma	**2.41* (2.18, 2.66)**	**2.25* (2.03, 2.50)**	**1.30* (1.14, 1.49)**
Some college, no degree	**2.29* (2.08, 2.53)**	**2.16* (1.96, 2.38)**	**1.44* (1.27, 1.62)**
College degree (ref)	1.00	1.00	1.00
Marital status			
Married (ref)	1.00	1.00	1.00
Divorced/Widowed/Separated	**1.72* (1.56, 1.89)**	**1.63* (1.47, 1.79)**	**1.23* (1.10, 1.37)**
Never married	**1.40* (1.25, 1.57)**	**1.40* (1.25, 1.58)**	**1.41* (1.24, 1.61)**
Living with partner	**2.28* (2.01, 2.59)**	**2.25* (1.98, 2.55)**	**1.52* (1.31, 1.77)**
Poverty status (4 categories)			
Less than 1.0 (below poverty threshold)	**1.47* (1.28, 1.69)**	**1.29* (1.12, 1.48)**	0.91 (0.75, 1.09)
1.00-1.99 times poverty threshold	**1.36* (1.21, 1.54)**	**1.24* (1.10, 1.41)**	0.94 (0.80, 1.10)
2.00-3.99 times poverty threshold	**1.30* (1.17, 1.44)**	**1.24* (1.12, 1.37)**	1.12 (0.99, 1.26)
4+ times poverty threshold (ref)	1.00	1.00	1.00
Missing	0.90 (0.72, 1.13)	0.89 (0.71, 1.12)	0.86 (0.68, 1.09)
Employment status			
Full-time employment (ref)	1.00	1.00	1.00
Part-time employment	0.92 (0.82, 1.03)	**0.88* (0.79, 0.99)**	1.03 (0.88, 1.20)
Currently not working	1.01 (0.92, 1.11)	**0.85* (0.76, 0.94)**	0.94 (0.83, 1.07)
Number of kids in family or household			
0 kids (ref)	1.00	1.00	1.00
1 kid	1.06 (0.93, 1.20)	1.09 (0.96, 1.23)	1.13 (0.98, 1.31)
2 kids	**0.79* (0.71, 0.89)**	**0.82* (0.73, 0.92)**	**0.85* (0.74, 0.98)**
3+ kids	**0.75* (0.65, 0.87)**	**0.80* (0.68, 0.93)**	0.93 (0.77, 1.13)

Table 4. continued **Odds Ratio**	**Demographic Model**	**Demographic + Health Characteristics Model**	**Demographic + Health Characteristics + Health Behaviors Model**
Region			
Northeast (ref)	1.00	1.00	1.00
Midwest	**1.34* (1.19, 1.51)**	**1.32* (1.17, 1.49)**	**1.29* (1.11, 1.49)**
South	**1.30* (1.15, 1.46)**	**1.29* (1.15, 1.45)**	**1.41* (1.23, 1.62)**
West	**1.48* (1.31, 1.66)**	**1.46* (1.30, 1.64)**	**1.79* (1.56, 2.05)**
Sexual orientation			
Gay, Lesbian, or bisexual	**1.88* (1.57, 2.25)**	**1.74* (1.45, 2.08)**	1.75* (1.40, 2.20)
Straight (ref)	1.00	1.00	1.00
Missing	0.80 (0.63, 1.03)	0.80 (0.61, 1.05)	0.87 (0.62, 1.20)
Self-reported health status			
Excellent/very good (ref)		1.00	1.00
Good		**1.31* (1.19, 1.44)**	1.09 (0.97, 1.23)
Fair/poor		**1.36* (1.21, 1.53)**	1.12 (0.98, 1.29)
Serious psychological distress			
Score = 13+		**1.87* (1.60, 2.18)**	**1.39* (1.15, 1.70)**
Score = 0-12 (ref)		1.00	1.00
Missing		0.94 (0.69, 1.29)	1.07 (0.73, 1.56)
Any functional limitations or disabilities			
Yes		**1.45* (1.32, 1.59)**	**1.38* (1.23, 1.55)**
No (ref)		1.00	1.00
Ever had asthma			
Yes		**1.22* (1.10, 1.36)**	**1.29* (1.14, 1.45)**
No (ref)		1.00	1.00
Body mass index			
Underweight			0.95 (0.67, 1.35)
Healthy weight (ref)			1.00
Overweight			1.01 (0.90, 1.13)
Obese			0.98 (0.85, 1.12)
Missing			**0.69* (0.50, 0.96)**
Alcohol drinking status			
Lifetime abstainer (ref)			1.00
Former drinker			**2.47* (1.95, 3.12)**
Current light/infrequent drinker			**3.10* (2.51, 3.83)**
Current moderate/heavy drinker			**3.62* (2.85, 4.60)**
Who met the 2008 federal physical activity guidelines			
Met neither physical activity guideline			**0.80* (0.71, 0.89)**
Met one physical activity guideline			**0.83* (0.74, 0.93)**
Met both physical activity guideline (ref)			1.00

Table 4. continued **Odds Ratio**	**Demographic Model**	**Demographic + Health Characteristics Model**	**Demographic + Health Characteristics + Health Behaviors Model**
Smoking status			
Never smoked			**0.04* (0.03, 0.04)**
Every day smoker, 1 quit attempt lasting at least 1 day in past year			**1.69* (1.45, 1.98)**
Every day smoker, no quit attempts in past year (ref)			1.00
Some day smoker, 1 quit attempt lasting at least 1 day in past year			0.96 (0.78, 1.17)
Some day smoker, no quit attempts in past year			**0.47* (0.37, 0.58)**
Former smoker, quit within past year			**1.26* (1.01, 1.57)**
Former smoker, quit 1+ year ago			**0.17* (0.15, 0.19)**
Number of observations in analysis	66,043	65,940	64,201
Approximate Chi-Square	5,975.14	6,592.15	18,130.53
-2 * Normalized Log likelihood for full model (degrees of freedom)	45,412.30 (30)	44,736.57 (36)	31,845.18 (51)

Statistically significant OR are indicated by asterisks (*) and are in boldface. CI are in parentheses.
Notes: ref = reference category; AIAN = American Indian/Alaska Native
GED = General Educational Development high school equivalency diploma.

In the Demographic Model (Column 2), ever use of e-cigarettes was more likely in 2015 than in 2014 (OR = 1.17), a finding consistent with Figure 1. Men (OR = 1.35) were more likely than women to have ever used e-cigarettes. Adults aged 18 to 24 were as likely as adults aged 25 to 44 to have ever used e-cigarettes, whereas adults aged 45 to 64 were less likely (OR = 0.25) and adults aged 65 and older were much less likely (OR = 0.15) than younger adults to have ever used e-cigarettes. Regarding race/ethnicity, ever use of e-cigarettes was comparable among non-Hispanic White and non-Hispanic American Indian/Alaska Native adults, whereas Hispanic (OR = 0.34), non-Hispanic Black (OR = 0.33), and non-Hispanic Asian (OR = 0.45) adults were much less likely than non-Hispanic Whites to have ever used e-cigarettes.

Compared to adults with a college degree, adults with less education were more likely to have ever used e-cigarettes, with adults who received GEDs being particularly

more likely (OR = 4.68) to have ever used e-cigarettes. In addition, divorced, widowed, or separated (OR = 1.72), never married (OR = 1.40), and cohabiting (OR = 2.28) adults were more likely to have ever used e-cigarettes than married adults. Poverty status was also associated with ever using e-cigarettes: adults living in families below the poverty threshold (OR = 1.47), 1.00-1.99 times the poverty threshold (OR = 1.36), and 2.00-3.99 times the poverty threshold (OR = 1.30) were all more likely to have ever used e-cigarettes than adults in families with incomes that were 4 or more times the poverty threshold. Lastly, employment status was not associated with ever e-cigarette use, making it the only explanatory variable that was not statistically significant in the demographic model (possibly because education and poverty status were associated rather strongly with ever use).

Adults who did not live with children and those living with one child were equally likely to have ever used e-cigarettes, while adults living with two children (OR = 0.79) and three or more children (OR = 0.75) were less likely than adults living with no children to have ever used e-cigarettes. Additionally, adults living in the Northeast part of the United States were less likely than adults in the Midwest (OR = 1.34), South (OR = 1.30), and West (OR = 1.48) to have ever used e-cigarettes. Lastly, gay, lesbian, or bisexual adults (OR = 1.88) were more likely than straight adults to have ever used e-cigarettes.

The addition of several health characteristics to the demographic model (Column 3) did not alter any of the associations previously described. In fact, the odds ratios remained very consistent in both magnitude and direction. Employment status was the

exception. Although it was not associated with ever using an e-cigarette in the demographic model, when controls for health characteristics were included in the second model, adults employed part-time and those not working at all were less likely (OR = 0.88 and OR = 0.85, respectively) than adults employed full-time to have ever used an e-cigarette. Adults working part-time or not at all may be more likely to have health problems; the addition of controls for such problems may have revealed the association between full-time employment status and ever using an e-cigarette. More importantly, the four health characteristics added to the second model all indicate that the presence of health problems of some sort *increased* the likelihood of ever using e-cigarettes. Adults in good (OR = 1.31) and fair or poor (OR = 1.36) were more likely than adults in excellent or very good health to have ever used e-cigarettes. In addition, adults in serious psychological distress (OR = 1.87) were more likely to have ever used e-cigarettes than adults not in such distress, while adults with a functional limitation or disability (OR = 1.45) were more likely than adults without such limitations or disabilities to have ever used an e-cigarette. Finally, adults who reported ever having asthma were more likely (OR = 1.22) than those not reporting asthma to have ever used an e-cigarette.

In the full model predicting ever use of an e-cigarette (Column 4 in Table 4), the addition of indicators of health behaviors do alter some, but not all, of the associations obtained in the previous model based on demographic and health characteristics. In particular, males continue to be more likely than women to have ever used an e-cigarette, but the association is weaker in the full model, as reflected by the smaller OR and in the statistics for the fit of the overall model (see Table 5). In addition, older adults in every

age group were statistically different than adults aged 18 to 24 and thus less likely than the youngest adults to have ever used an e-cigarette.

Adults with college degrees and those without a high school diploma or GED were equally likely to have ever used an e-cigarette, whereas adults with GEDs (OR = 1.51), high school diplomas (OR = 1.30), and those with some college but no degree (OR = 1.44) were all more likely to have ever used an e-cigarette than college graduates. Although receiving a GED remained associated with ever using an e-cigarette, the introduction of controls for health behaviors reduced the magnitude of this effect in the full model, as opposed to the odds ratios reported in the previous models. Moreover, the introduction of health behaviors to the full model explained the association between poverty status and ever using an e-cigarette reported in the simpler models (although the variable contributes to the model, as indicated by the statistically significant *p* value in Table 5). And perhaps not surprisingly, the addition of controls for health behaviors in the full model also explained the association between employment status and health characteristics obtained in the second model.

Adults living with two children were less likely (OR = 0.85) than adults living with no children to have ever used an e-cigarette in the final model, but there was no association between adults living with either one or three or more children and ever using an e-cigarette. In addition, region and sexual orientation continued to be associated with ever using an e-cigarette: adults living in the Northeast were less likely to have ever used an e-cigarette than adults living in the Midwest (OR = 1.29), South (OR = 1.41), and

West (OR = 1.79), while gay, lesbian, and straight adults were more likely (OR = 1.75) to have ever used an e-cigarette than straight adults.

The addition of controls for health behaviors explained away the previously reported association between health status and ever using an e-cigarette, but adults with serious psychological distress (OR = 1.39), adults with disabilities (OR = 1.38), and adults who had ever had asthma (OR = 1.29) remained more likely to have ever used e-cigarettes than adults without psychological distress, adults without disabilities, and those not having asthma, respectively.

As for the specific controls for health behaviors, body mass index was not associated with ever using an e-cigarette, but adults who did not supply enough information to have a BMI calculated (OR = 0.69) were less likely to have ever used an e-cigarette than adults with a healthy weight. (Note that this was the only "missing" term in this series of models to be statistically associated with the dependent variable, although it does not contribute anything to the overall model per Table 5.) Alcohol drinking status was significantly associated with ever using an e-cigarette: former drinkers (OR = 2.47), current infrequent and light drinkers (OR = 3.10), and current moderate and heavy drinkers (OR = 3.62) were all more likely than lifetime abstainers to have ever used an e-cigarette, consistent with the notion that engaging in risky behaviors may promote other risky behaviors. Somewhat surprisingly, active adults who met the 2008 federal physical activity guidelines by participating in leisure-time aerobic and muscle-strengthening activities were *more* likely than adults who met neither guideline (OR = 0.80) or only one guideline (OR = 0.83) to have ever used e-cigarettes.

Smoking status, which considers quit attempts among current cigarette smokers and whether former cigarette smokers quit within the past year, was also strongly associated with ever use of an e-cigarette. Other than the intercept term, this explanatory variable contributed the most to the full model's Wald Chi Square score (Table 5). Relative to "committed smokers" – every day smokers with no quit attempts in the past year – adults who had never smoked were very unlikely to have ever used an e-cigarette (OR = 0.04). Every day smokers who had one quit attempt lasting at least one day during the past year (OR = 1.69) were more likely than every day smokers with no quit attempts (i.e., committed smokers) to have ever used e-cigarettes. There was no difference in the extent to which committed smokers and some day smokers with one quit attempt in the past year had ever used e-cigarettes, while some day smokers with no quit attempts were less likely (OR = 0.47) than committed smokers to have ever used e-cigarettes. Finally, former smokers who quit within the past year were more likely (OR = 1.26) than committed smokers to have ever used an e-cigarette, while former smokers who quit one or more years ago were considerably less likely (OR = 0.17) to have ever used an e-cigarette.

Table 5. Overall Statistics for the Full Model Predicting Ever E-Cigarette Use (column 4, Table 4), NHIS, 2014-2015

Variable	Degrees of freedom	Wald Chi Square Statistics	P-value
Overall model	52	13,753.94	0.0000
Model minus intercept	51	8,068.14	0.0000
Intercept	.	.	.
Year	1	50.70	0.0000
Sex	1	6.87	0.0087
Age group	3	833.67	0.0000
Race/ethnicity	4	214.79	0.0000
Education	4	56.08	0.0000
Marital status	3	45.20	0.0000
Poverty status	4	12.89	0.0118
Employment status	2	1.31	0.5182
Number of kids in family or household	3	13.36	0.0039
Region	3	76.05	0.0000
Sexual orientation	2	3.41	0.0000
Self-reported health status	2	11.23	0.1817
Serious psychological distress	2	30.25	0.0036
Any functional limitations or disabilities	1	16.25	0.0000
Ever had asthma	1	16.25	0.0000
Body mass index	4	5.34	0.2544
Alcohol drinking status	3	123.87	0.0000
Who met the 2008 physical activity guidelines	2	17.42	0.0002
Smoking status	6	**3,153.14**	0.0000

Multivariate analysis predicting current use of e-cigarettes

OR and 95% confidence intervals obtained from the second logistic model predicting current use of e-cigarettes among all adults are shown in Table 6. Again, results are presented for three models: the "Demographic model" only (column 2), "Demographic + Health Characteristics Model" (column 3), and "Demographic + Health Characteristics + Health Behaviors Model," or the full model (column 4). Statistically significant odds ratios are indicated by asterisks and are in bold font.

In the demographic model (column 2, Table 6), current use of e-cigarettes was comparable across the two years, which is consistent with the results in Figure 1 that showed no difference in the percentages for current use in 2014 and 2015. As with the model predicting ever use of e-cigarettes, men (OR = 1.49) were more likely than women to be current users of e-cigarettes. Adults aged 18-24 were as likely as adults aged 25-44 and aged 45-64 to currently be using e-cigarettes, but adults aged 65 and older were considerably less likely (OR = 0.24) than the youngest adults to be current users of e-cigarettes. Regarding race/ethnicity, current use of e-cigarettes was comparable among non-Hispanic White and non-Hispanic American Indian/Alaska Native adults, but Hispanic (OR = 0.30), non-Hispanic Black (OR = 0.29), and non-Hispanic Asian (OR = 0.49) adults were much less likely than non-Hispanic White adults to be currently using e-cigarettes.

Table 6. Adjusted odds ratios and confidence intervals (in parentheses) predicting current use of e-cigarettes, U.S. adults aged 18 years or older; NHIS, 2014-2015

Odds ratio	Demographic Model	Demographic + Health Characteristics Model	Demographic + Health Characteristics + Health Behaviors Model
Year			
2014 (ref)	1.00	1.00	1.00
2015	0.93 (0.80, 1.07)	0.91 (0.79, 1.05)	1.03 (0.88, 1.19)
Sex			
Male	**1.49* (1.29, 1.72)**	**1.53* (1.32, 1.77)**	**1.35* (1.16, 1.57)**
Female (ref)	1.00	1.00	1.00
Age			
18-24 (ref)	1.00	1.00	1.00
25-44	1.26 (0.98, 1.61)	1.11 (0.87, 1.40)	**0.72* (0.56, 0.91)**
45-64	0.84 (0.63, 1.12)	**0.67* (0.52, 0.86)**	**0.54* (0.42, 0.70)**
65+	**0.24* (0.17, 0.35)**	**0.21* (0.15, 0.29)**	**0.24* (0.17, 0.34)**
Race/ethnicity			
Hispanic	**0.30* (0.23, 0.38)**	**0.31* (0.24, 0.39)**	**0.57* (0.44, 0.74)**
Non-Hispanic black	**0.29* (0.24, 0.36)**	**0.29* (0.24, 0.36)**	**0.38* (0.31, 0.48)**
Non-Hispanic AIAN	1.02 (0.55, 1.90)	0.98 (0.51, 1.88)	1.27 (0.67, 2.43)
Non-Hispanic Asian	**0.49* (0.36, 0.67)**	**0.52* (0.38, 0.71)**	**0.70* (0.51, 0.97)**
Non-Hispanic white (ref)	1.00	1.00	1.00
Education (5 categories)			
No high school diploma or GED	**2.30* (1.80, 2.93)**	**1.98* (1.55, 2.52)**	0.96 (0.74, 1.24)
GED recipient	**3.70* (2.78, 4.92)**	**3.21* (2.41, 4.28)**	1.18 (0.86, 1.62)
High school diploma	**2.78* (2.28, 3.39)**	**2.56* (2.10, 3.12)**	**1.37* (1.10, 1.72)**
Some college, no degree	**2.57* (2.10, 3.14)**	**2.39* (1.97, 2.90)**	**1.52* (1.23, 1.87)**
College degree (ref)	1.00	1.00	1.00
Marital status			
Married (ref)	1.00	1.00	1.00
Divorced/Widowed/Separated	**1.63* (1.39, 1.91)**	**1.54* (1.31, 1.81)**	1.15 (0.97, 1.37)
Never married	**1.26* (1.04, 1.53)**	**1.26* (1.04, 1.53)**	1.21 (0.98, 1.49)
Living with partner	**2.40* (1.87, 3.10)**	**2.34* (1.83, 3.00)**	**1.58* (1.22, 2.05)**
Poverty status (4 categories)			
Less than 1.0 (below poverty threshold)	**1.43* (1.12, 1.81)**	1.23 (0.97, 1.57)	0.94 (0.71, 1.25)
1.00-1.99 times poverty threshold	**1.34* (1.07, 1.69)**	1.20 (0.96, 1.52)	0.92 (0.70, 1.21)
2.0-3.99 times poverty threshold	1.19 (0.96, 1.48)	1.13 (0.91, 1.40)	1.00 (0.78, 1.28)
4+ times poverty threshold (ref)	1.00	1.00	1.00
Missing	1.10 (0.66, 1.83)	1.09 (0.65, 1.82)	1.07 (0.69, 1.66)
Employment status			
Full-time employment (ref)	1.00	1.00	1.00
Part-time employment	1.14 (0.92, 1.42)	1.10 (0.88, 1.36)	1.27 (0.99, 1.63)
Currently not working	**1.31* (1.11, 1.53)**	1.08 (0.90, 1.30)	1.16 (0.96, 1.40)
Number of kids in family or household			
0 kids (ref)	1.00	1.00	1.00
1 kid	**1.33* (1.00, 1.77)**	**1.37* (1.03, 1.81)**	**1.43* (1.06, 1.94)**
2 kids	0.82 (0.67, 1.01)	0.86 (0.70, 1.06)	0.95 (0.75, 1.19)
3+ kids	0.86 (0.67, 1.09)	0.92 (0.72, 1.17)	1.05 (0.80, 1.38)
Region			
Northeast (ref)	1.00	1.00	1.00
Midwest	**1.36* (1.06, 1.74)**	**1.34* (1.05, 1.71)**	1.26 (0.97, 1.63)
South	**1.52* (1.20, 1.92)**	**1.50* (1.19, 1.89)**	**1.58* (1.22, 2.05)**
West	**1.60* (1.28, 2.01)**	**1.58* (1.26, 1.99)**	**1.74* (1.35, 2.23)**

Table 6. continued **Odds Ratio**	**Demographic Model**	**Demographic + Health Characteristics Model**	**Demographic + Health Characteristics + Health Behaviors Model**
Sexual orientation			
Gay, Lesbian, or bisexual	**1.79* (1.35, 2.38)**	**1.66* (1.25, 2.21)**	**1.62* (1.19, 2.20)**
Straight (ref)	1.00	1.00	1.00
Missing	0.73 (0.49, 1.08)	0.73 (0.44, 1.21)	0.80 (0.45, 1.43)
Self-reported health status			
Excellent/very good ((ref)		1.00	1.00
Good		**1.42* (1.20, 1.68)**	**1.22* (1.02, 1.46)**
Fair/poor		**1.74* (1.43, 2.12)**	**1.50* (1.22, 1.85)**
Serious psychological distress			
Score = 13+		**1.38* (1.07, 1.78)**	1.02 (0.79, 1.32)
Score = 0-12 (ref)		1.00	1.00
Missing		0.94 (0.52, 1.70)	0.97 (0.50, 1.89)
Any functional limitations or disabilities			
Yes		**1.24* (1.04, 1.48)**	1.12 (0.92, 1.36)
No (ref)		1.00	1.00
Ever had asthma			
Yes		**1.29* (1.05, 1.59)**	**1.30* (1.06, 1.59)**
No (ref)		1.00	1.00
Body mass index			
Underweight			1.15 (0.69, 1.89)
Healthy weight (ref)			1.00
Overweight			1.02 (0.88, 1.20)
Obese			**0.80* (0.67, 0.96)**
Missing			0.86 (0.52, 1.42)
Alcohol drinking status			
Lifetime abstainer (ref)			1.00
Former drinker			1.19 (0.86, 1.66)
Current light/infrequent drinker			**1.53* (1.15, 2.02)**
Current moderate/heavy drinker			1.32 (0.97, 1.79)
Who met the 2008 federal physical activity guidelines			
Met neither physical activity guideline			0.89 (0.73, 1.08)
Met one physical activity guideline			0.86 (0.70, 1.05)
Met both physical activity guideline (ref)			1.00

Table 6. continued **Odds Ratio**	**Demographic Model**	**Demographic + Health Characteristics Model**	**Demographic + Health Characteristics + Health Behaviors Model**
Smoking status			
Never smoked			**0.05* (0.04, 0.06)**
Every day smoker, 1 quit attempt lasting at least 1 day in past year			**1.66* (1.33, 2.08)**
Every day smoker, no quit attempts in past year (ref)			1.00
Some day smoker, 1 quit attempt lasting at least 1 day in past year			**1.80* (1.39, 2.33)**
Some day smoker, no quit attempts in past year			0.78 (0.54, 1.14)
Former smoker, quit within past year			**2.19* (1.67, 2.88)**
Former smoker, quit 1+ year ago			**0.31* (0.25, 0.39)**
Number of observations in analysis	66,041	65,938	64,200
Approximate Chi-Square	1,728.10	1,928.71	5,281.77
-2 * Normalized Log likelihood for full model (degrees of freedom)	18,660.28 (30)	18,440.13 (36)	14,527.43 (51)

Notes: ref = reference category; AIAN = American Indian/Alaska Native; GED = General Educational Development diploma.

Compared to adults with a college degree, adults who did not complete high school (OR = 2.30), received a GED (OR = 3.70), graduated from high school (OR = 2.78), or completed some college (OR = 2.57) were more likely to be current users of e-cigarettes. In addition, divorced, widowed, or separated (OR = 1.63), never married (OR = 1.26), and cohabiting (OR = 2.40) adults were more likely to be current users of e-cigarettes than married adults. Poverty status was also somewhat associated with current use of e-cigarettes: adults living in families below the poverty threshold (OR = 1.43) or in families with incomes that were 1.00-1.99 times the poverty threshold (OR = 1.34) were both more likely to be currently using e-cigarettes than adults in families with incomes that were 4 or more times the poverty threshold. Adults who were not currently working were more likely than adults employed full-time to currently use e-cigarettes (OR = 1.31), as were adults residing in families that included one child under age 18 (OR =

1.33) compared with those who did not reside with any children. Note that there was no association between current e-cigarette use and adults working part-time (relative to adults working full time) or for adults living in families with either two or three or more children (relative to adults living in homes without children). Regionally, adults living in the Midwest (OR = 1.36), South (OR = 1.52), and West (OR = 1.60) were all more likely to currently use e-cigarettes than adults in the Northeast. Lastly, gay, lesbian, or bisexual adults (OR = 1.79) more likely than straight adults to be current users of e-cigarettes.

Once controls for health characteristics were added to the demographic model (column 3 in Table 6), adults aged 45 to 64 (OR = 0.67) as well as those aged 65 and older (OR = 0.21) were less likely than adults aged 18 to 24 to be current e-cigarette users. Also, the addition of health characteristics explained away the effects associated with poverty and employment status obtained from the model consisting only of demographic characteristics. This is not a particularly surprising finding given that health has been shown in countless studies to be very strongly correlated with both employment and poverty status. Regarding the remaining demographic, social, and economic controls, the addition of health characteristics did not appreciably alter the odds ratios obtained from the "Demographic Model." More importantly, the four controls for health characteristics were all significantly associated with current use of e-cigarettes in the "Demographic + Health Characteristics Model," such that adults with health problems were more likely to be current users of e-cigarettes. Adults in good (OR = 1.42) and fair or poor (OR = 1.74) were more likely to be currently using e-cigarettes than adults in excellent or very good health. In addition, serious psychological distress (OR = 1.38),

disability (OR = 1.24), and ever having asthma (OR = 1.29) were both associated with current use of e-cigarettes.

In the full model predicting current use of e-cigarettes (column 4 in Table 6), indicators of health behaviors altered some, but not all, of the associations obtained in the previous model that included only demographic, social, economic, and health characteristics. In particular, the addition of health behaviors explained away the effects associated with serious psychological distress and disability obtained in the previous model, as well as some, but not all, of the effects associated with education, marital status, and region. Note that adults with less education (i.e., those not graduating from high school and GED recipients) were as likely as college graduates to be currently using e-cigarettes, and divorced/widowed/separated and never married adults were as likely as married adults to be current users of e-cigarettes. While adults in the Northeast and Midwest were equally likely to be current e-cigarette users, adults in the South (OR = 1.58) and especially the West (OR = 1.74) were more likely that adults in the Northeast to be current users of e-cigarettes. In addition, older adults in every age group were less likely than the youngest adults to be currently using e-cigarettes.

Regarding the effects associated with health behaviors, obese adults (OR = 0.80) were less likely that adults of a healthy weight to be current users of e-cigarettes, while adults who currently drank alcohol lightly or infrequently (OR = 1.53) were more likely to be current users of e-cigarettes than adults who were lifetime abstainers of alcohol. And, in contrast to results from the models predicting ever use of e-cigarettes, leisure-

time physical activity, as indicated by compliance with the 2008 federal physical activity guidelines, was not associated with current e-cigarette use.

Table 7. Overall Statistics for the Full Model Predicting Current E-Cigarette Use (column 4, Table 6), NHIS, 2014-2015

Variable	**Degrees of freedom**	**Wald Chi Square Statistics**	**P-value**
Overall model	52	10,402.82	0.0000
Model minus intercept	51	2,257.95	0.0000
Intercept	.	.	.
Year	1	0.11	0.7429
Sex	1	14.90	0.0001
Age group	3	78.87	0.0000
Race/ethnicity	4	87.55	0.0000
Education	4	26.94	0.0000
Marital status	3	12.34	0.0063
Poverty status	4	0.81	0.9371
Employment status	2	4.74	0.0935
Number of kids in family or household	3	8.40	0.0384
Region	3	24.23	0.0000
Sexual orientation	2	9.98	0.0068
Self-reported health status	2	14.87	0.0006
Serious psychological distress	2	0.04	0.9819
Any functional limitations (or disabilities)	1	1.32	0.2499
Ever had asthma	1	6.59	0.0103
Body mass index	4	8.72	0.0684
Alcohol drinking status	3	13.93	0.0030
Who met the 2008 physical activity guidelines	2	2.24	0.3260
Smoking status	6	**933.27**	0.0000

By far the strongest explanatory variable associated with current use of e-cigarettes was (tobacco) cigarette smoking status, which takes into account quit attempts among current cigarette smokers and whether former cigarette smokers quit within the past year. Other than the intercept term, smoking status contributed the most to the full model's Wald Chi Square score (Table 7), a finding that is again consistent with Flay and

Petraitis' theory. This effect can also be seen in the changes in the model statistics and degrees of freedom reported at the bottom of Table 6: The Chi Square and log likelihood scores obtained from the final model significantly increased and decreased, respectively, when compared with the scores from the previous model. Relative to "committed smokers" – every day smokers with no quit attempts in the past year – adults who had never smoked were very unlikely to be currently using e-cigarettes (OR = 0.05). The odds of currently using e-cigarettes among every day smokers who had one quit attempt in the past year were 1.66 times the odds of every day smokers with no quit attempts. There was no difference in the extent to which committed smokers and some day smokers with no quit attempts in the past year were currently using e-cigarettes, while some day smokers with at least one quit attempt in the past year were more likely (OR = 1.80) than committed smokers to be currently using e-cigarettes. Finally, former smokers who quit within the past year were considerably more likely (OR = 2.19) than committed smokers to be currently using e-cigarettes, while former smokers who quit one or more years ago were considerably less likely (OR = 0.31) to be current users of e-cigarettes. Taken together, findings from both models predicting ever and current use of e-cigarettes are thus consistent with the notion that e-cigarettes may be used by adults who are trying to reduce or quit smoking tobacco cigarettes. But it is important to point out that the NHIS did not specifically ask sample adults why they were using e-cigarettes, so this should not be considered a conclusive finding by any means.

Summary

In this cross-sectional research study, the relationship between ever/past and current e-cigarette use (ever/past and current) and demographic, social, economic, health characteristic and behavior indicators were examined. Based on the results of the multivariate analyses predicting ever/past use of e-cigarettes (Research Question 1), the alternative hypotheses that there are significant relationships between ever/past e-cigarette use and demographic, social, and economic indicators, health characteristic indicators, and health behavior indicators were accepted and the null hypotheses were rejected. Furthermore, based on the results of the multivariate analyses predicting current of e-cigarettes (Research Question 2), the alternative hypotheses that there are significant relationships between current e-cigarette use and demographic, social, and economic indicators, health characteristic indicators, and health behavior indicators were also accepted and the null hypotheses were rejected. Additionally, support for Flay and Petraitis' (1994) TTI was obtained from both sets of models: other than the intercept, the controls for smoking status were by far the strongest predictors of both ever/past e-and current e-cigarette use, which is what would be expected concerning a proximate explanatory variable.

CHAPTER V
DISCUSSION

The purpose of this cross-sectional research study was to examine the relationships between e-cigarette use (ever/past and current) and demographic, social, economic, health characteristic and behavior indicators. The data used for this study were the 2014 and 2015 National Health Interview Survey. This study was designed to answer two research questions: (a) What is the relationship between ever/past e-cigarette use and demographic, social, economic, health characteristic and behavior indicators and (b) What is the relationship between current e-cigarette use and demographic, social, economic, health characteristic and behavior indicators? The results in chapter four showed that nearly all of the explanatory variables used in the logistic regression models to predict ever/past and current e-cigarette use were statistically significant predictors of both outcomes of interest, and in a manner outlined by Flay and Petraitis' Theory of Triadic Influence. In this chapter, the results and how they relate to previous findings will be briefly summarized, and then follow with a discussion of the implications and conclusions of the findings.

Discussion of Results

Regarding Research Question 1, what demographic, social, and economic characteristics were associated with ever using an e-cigarette net of the other explanatory variables in the final model? The short answer is that nearly all of "Demographic" variables were statistically significant predictors of ever e-cigarette use. Some of the more important findings are summarized below:

- Ever/past e-cigarette use increased in 2015 relative to 2014;
- Males were more likely than females to have ever used an e-cigarette;
- The youngest adults (18 to 24 years) were more likely than older adults to have ever used an e-cigarette;
- Non-Hispanic Whites were more likely than Hispanics, non-Hispanic Blacks, and non-Hispanic Asians to have ever used an e-cigarette (non-Hispanic American Indian/Alaska Natives were not statistically different from non-Hispanic Whites);
- High school graduates, GED recipients, and adults with some college were more likely than college grads to have ever used an e-cigarette;
- Divorced/widowed/separated, never married, and cohabiting adults were more likely than married adults to have ever used an e-cigarette;
- Adults in the Midwest, South, and (especially) West regions were more likely than adults in the Northeast to have ever used an e-cigarette;
- Gay, lesbian, or bisexual adults were more likely than straight adults to have ever used an e-cigarette.

The presence of two or more children in the family was negatively associated with ever e-cigarette use. Although this effect was weaker in the full model, such that adults living in a family with only two children were less likely than adults in families with no children to have ever used an e-cigarette. Lastly, two economic factors, poverty status and employment status, were NOT significantly associated with ever use of e-cigarettes; these effects were explained away – that is, became statistically insignificant – when health behaviors were added to the model.

What health characteristics were significantly associated with ever using an e-cigarette? Health status (being in fair/poor or good health relative to being in excellent or

very good health) was NOT associated with ever use – these effects were also explained away when health behaviors were added to the model. However,

- Adults in serious psychological distress were more likely than those not in distress to have ever used an e-cigarette;
- Adults with disabilities were more likely than those not disabled to have ever used an e-cigarette;
- Adults ever diagnosed with asthma were more likely than those not diagnosed to have ever used an e-cigarette.

Lastly, what health behaviors were significantly associated with ever using an e-cigarette? Smoking status was by far the strongest predictor of ever using an e-cigarette. In particular, relative to every day cigarette smokers with no quit attempts in the past year (referred to as committed cigarette smokers),

- Adults who had never smoked were considerably less likely to have ever used an e-cigarette;
- Every day smokers with one quit attempt lasting at least one day in the past year were more likely to have ever used an e-cigarette;
- Some day smokers with no quit attempts in the past year were less likely to have ever used an e-cigarette;
- Former smokers who quit within the past year were more likely to have ever used an e-cigarette;
- Former smokers who quit more than 1 year ago were less likely to have ever used an e-cigarette.

There was no statistically significant difference between every day smokers with no quit attempts and some day smokers with one quit attempt in the past year. Regarding other health behaviors,

- Former drinkers, current light/infrequent, and current moderate/heavy drinkers progressively more likely than lifetime abstainers to have ever used an e-cigarette;
- Adults most physically active during their leisure-time were more likely than those less active or not at all active to have ever used an e-cigarette.

Underweight, overweight, and obesity (relative to being at a healthy weight) were not significantly associated with ever having used an e-cigarette. However, the "missing' category with respect to BMI was statistically associated with ever having used an e-cigarette (and the only one of the four missing categories retained in the models to be significantly related to the outcome).

How should this result be interpreted? To be missing with respect to an explanatory variable has little substantive meaning. However, the fact that the effect was negative rather than positive is important: adults who did not report enough information to calculate a valid BMI were not raising the likelihood of ever using an e-cigarette. On the other hand, had the effect been positive, being "missing" with respect to BMI information would significantly raise the likelihood of ever using an e-cigarette. Such a finding would require more investigation in order to be understood. In this particular instance, simply having more years of NHIS data would probably eliminate this puzzling finding.

Regarding Research Question 2, what demographic, social, and economic characteristics were associated with current use of e-cigarettes net of the other explanatory variables in the final model? Again, the short answer is that nearly all of "Demographic" variables were statistically significant predictors of current e-cigarette use, although generally fewer categories within each explanatory variable were significant different from their respective reference groups (most likely a result of the smaller number of cases available for these analyses).

Some of the more important findings are summarized below:

- Current e-cigarette use did not change in 2015 relative to 2014;
- Males were more likely than females to currently be using e-cigarettes;
- Current use of e-cigarettes declined with age, such that the youngest adults (18 to 24 years) were more likely than older adults to currently be using e-cigarettes;
- Non-Hispanic Whites were more likely than Hispanics, non-Hispanic Blacks, and non-Hispanic Asians to currently be using e-cigarettes (again, non-Hispanic American Indian/Alaska Natives were not statistically different from non-Hispanic Whites);
- High school graduates and adults with some college were more likely than college grads to currently be using e-cigarettes;
- Cohabiting adults were more likely than married adults to currently be using e-cigarettes;
- Adults in the South and West regions were more likely than adults in the Northeast to currently be using e-cigarettes;
- Gay, lesbian, or bisexual adults were more likely than straight adults to currently be using e-cigarettes.

Analysis of current e-cigarette use, adults residing in a family with one child were statistically more likely to be current e-cigarette users than adults not residing with any children. Thus, findings regarding ever and current use of e-cigarettes are at odds with one another with respect to having children present in the home. Note that this explanatory variable only indicates that adults are living with children, and does not consider whether they are parents to any of these children. A more refined indicator that takes relationship into account would probably yield more informative and consistent results. Lastly, the two economic factors in analysis, poverty status and employment status, were again NOT significantly associated with current use of e-cigarettes; the addition of health characteristics explained away both effects.

What health characteristics were significantly associated with current use of e-cigarettes? Unlike the results from the "ever" analysis, being psychologically distressed or disabled were not associated with current use; these effects were both explained away when health behavior indicators were added to the full model. Moreover,

- Adults in fair/poor or good health were more likely than adults in excellent/very good health to currently use e-cigarettes;
- Adults ever diagnosed with asthma were more likely than those not diagnosed to currently use e-cigarettes.

Lastly, what health behaviors were significantly associated with current use of e-cigarettes? As with the "ever" models, smoking status was the strongest predictor of current use. In particular, relative to every day cigarette smokers with no quit attempts in the past year (the so-called committed cigarette smokers),

- Adults who had never smoked were considerably less likely to currently use e-cigarettes;
- Every day smokers with one quit attempt lasting at least one day in the past year were more likely to currently use e-cigarettes;
- Some day smokers with one quit attempt in the past year were more likely to currently use e-cigarettes;
- Former smokers who quit within the past year were more likely to currently use e-cigarettes;
- Former smokers who quit more than 1 year ago were less likely to be current users of e-cigarettes.

There was no statistically significant difference between every day smokers with no quit attempts and some day smokers with no quit attempts in the past year. Regarding other health behaviors,

- Obese adults were less likely than adults with a healthy weight to currently use e-cigarettes;
- Current light/infrequent drinkers more likely than lifetime abstainers to currently use e-cigarettes.

Unlike the model predicting ever/past use of e-cigarettes, leisure-time physical activity was not associated with current use.

The findings obtained from both models predicting ever/past and current use of e-cigarettes were in line with previous research findings. Schoenborn and Gindi's (2015) results were consistent with respect to gender, which is not surprising since they used the 2014 NHIS for their analysis. In contrast to Schoenborn and Gindi's findings, Grana, Benowitz, et al. (2014) reported that e-cigarette awareness is more prevalent among men

in the United States, but more women tend to try e-cigarettes. However, this conclusion was based upon a review of approximately 80 published journal articles, reports, news articles, and web sites rather than an analysis of data, and they did not explain how they compared these sources or reached this conclusion. For example, were journal papers given more weight than web sites? It is thus difficult to reconcile why their conclusions conflict with Schoenborn and Gindi, as well as with my results.

Results with respect to age are also consistent with previous research. Non-cigarette tobacco product use, such as hookah, cigars, e-cigarettes, and smokeless tobacco, is increasing in the United States, especially among young adults, and the prevalence of e-cigarette use is also highest among young adults (Adkison et al., 2013; Mays et al., 2016; Pearson et al., 2012; Regan et al., 2011, Schoenborn and Gindi, 2015). My results are also consistent with Flay and Petraitis' (1994) TTI. Specifically, HHS (2012) noted that tobacco promotion can influence adolescents during the early stages of their development when they form attitudes and beliefs about tobacco. HHS related that at this level, tobacco advertising and promotion influence is through mediated pathways. Hence, distal-level factors are directly influenced by advertising, promotion, industry-sponsored antismoking ads, and smoking in movies, such as exposure to other smokers, peer attitudes, cultural practices, and positive and negative beliefs about smoking consequences. Consequently, HHS indicated that researchers who use peer and family smoking as independent variables understate advertising effects.

Findings regarding race/ethnicity and ever/past and current e-cigarette use can also be interpreted in the context of Flay and Petraitis' (1994) TTI. Snyder and Flay

(2012) reported that at the ultimate level, causes are broad and quite stable, and that individuals have little control over their cultural environment. In addition, ultimate or underlying causes are the furthest removed from behavior, for example, biological susceptibility, poverty rates, politics, policy, religions, cultural practices, mass media, socioeconomic status, modern society's pursuit of economic growth, age, ethnicity, and personality (Flay et al., 2009; Snyder & Flay, 2012). Snyder and Flay noted that these effects are the most pervasive as they influence many behaviors, are the most mediated, and frequently the most difficult for any individual or program to change.

The conclusion that adults with college degrees are less likely to have ever used an e-cigarette than adults with less education are in contrast to findings by King et al. (2015), who found that adults with some college had greater odds of ever using an e-cigarette than those with a high school diploma. On the other hand, Levy, Yuan, and Yameng (2017) found that regular e-cigarette use was higher among those with an associate degree or a high school diploma than among high school drop-outs or college graduates. Findings with respect to education are likely to be different across studies for a variety of reasons: surveys ask about education differently (e.g., completed education and attained education are not the same thing), sample sizes are likely to be variable, and researchers may use different educational categories as the reference group. The NHIS, for example, does not contain an indicator of current school enrollment, so it is thus likely that a sizable number of respondents in the youngest age group in analysis – adults aged 18 to 24 – have not yet completed their education. The resulting category "Some College" probably includes equal numbers of dropouts and students because there is no

way to distinguish between them. My results may thus underestimate findings regarding college graduates and ever/past or current e-cigarette use. Longitudinal data is needed to disentangle the relationship between educational transitions and e-cigarette usage.

Findings with regard to marital status – that currently married persons were less likely to ever use an e-cigarette than those not currently married – are consistent with the literature as Levy et al. (2017) also found that both ever and current e-cigarette use was lower among married adults with their spouse present. At first glance, findings with respect to employment status – that it is not related to ever/past or current e-cigarette use – appear to be contrary to those of Levy et al. (2017), who found that ever, current, and regular e-cigarette use were lower among those employed. But this was based on frequency table analyses; when Levy et al. predicted e-cigarette use in a logistic regression model containing a number of explanatory variables, employment status was unrelated to ever/past or current e-cigarette use. They too noted that while their analysis data set was quite large (over 100,000 respondents), it was cross-sectional and did not allow them to measure the impact of individual transitions over time.

Results showing that adults living in the northeastern U.S. were less likely than adults living in other regions of the U.S. to have ever used e-cigarettes are also consistent with previous researchers who noted that Northeast states, such as New York, New Jersey, and Massachusetts, were among the first to impose strict age restrictions on tobacco sales that also included e-cigarettes (Winickoff, Gottlieb, & Mello, 2014).

Discovery that gay, lesbian, or bisexual adults were more likely than straight adults to have ever used e-cigarettes is also consistent with the literature as Johnson et al.

(2016) reported increased e-cigarette use among sexual minority populations, including lesbian, gay, and bisexual individuals, and gender minority such as transgender individuals. In addition, results indicating that asthmatics were more likely to be ever/past or current users of e-cigarettes are consistent with the literature as Choi and Bernat (2016, p. 446) found that the prevalence of ever and past 30-day e-cigarette use among students who reported having asthma was 10.4% and 5.3%, respectively, compared with 7.2% and 2.5%, respectively, among those not having asthma.

As for findings regarding health behaviors, the substantive BMI categories were not associated with ever using an e-cigarette, but obese adults were less likely than adults of a healthy weight to be current users of e-cigarettes. The latter finding is somewhat at odds with Lanza et al. (2017), who found that both obesity status and greater deviation from one's group BMI norm were associated with a higher likelihood of belonging to the "cigarette/electronic tobacco use" class. This discrepancy between my results and theirs may thus be explained by the fact that our dependent variables are not strictly comparable. In addition, my findings indicated that adults who met the 2008 federal physical activity guidelines by participating in LTPA were more likely than adults who met neither guideline or only one guideline to have ever used e-cigarettes is somewhat consistent with the literature as Pokhrel et al. (2015) reported that participants agreed that e-cigarette use was more conducive to physical activity because e-cigarettes did not affect their ability to perform during or before physical activity unlike cigarette smoking. However, results suggest that while physically active adults may have been willing to give e-cigarettes a try (as reflected by the statistically significant and positive relationship

between meeting the guidelines via LTPA and ever/past e-cigarette use), they did not continue to use e-cigarettes, as indicated by the statistically insignificant odds ratio for meeting the 2008 federal physical activity guidelines via LTPA in second analysis predicting current e-cigarette use.

Lastly, many previous studies have found statistically significant associations between e-cigarette use and alcohol consumption (Cohn et al., 2016; HHS, 2016; Littlefield et al., 2015; Saddleson et al., 2015) and e-cigarettes and smoking (Schoenborn and Gindi, 2015; Adkison et al., 2013; Dockrell et al, 2013; Grana, Benowitz, et al., 2014; King et al., 2013). My findings are consistent with respect to both magnitude and direction.

Conclusion/Implications

People who focus on health promotion should know what causes health-related behaviors (HRBs) and how to successfully promote health-enhancing behaviors or discourage health-compromising behaviors (Flay, Snyder, & Petraitis, 2009), such as smoking e-cigarettes. This knowledge has been evasive because (a) there are many and different causes of behavior as each cause is only one piece among various causes; (b) different behavior theories have focused on different aspects of the puzzle; (c) theories are difficult to confirm, which causes uncertainty; and (d) the theory scope limits the translation of any theory into health promotion programs; thus, narrowly focused theories result in narrowly focused interventions (Flay et al., 2009; Petraitis, Flay, and Miller, 1995).

The findings raise particular concerns about e-cigarette use among vulnerable adults who may be sick, disabled, asthmatic, or struggling with psychological distress and using e-cigarettes to self-medicate or cope with pain – and because they believe that e-cigarettes are supposed to be "safer" than tobacco cigarettes. Additionally, claims that e-cigarettes can be used as a cessation aid for quitting tobacco cigarettes may appeal to current cigarette smokers who have trying to quit. Johnson et al. (2016) highlighted the importance of tobacco control efforts designed to reach sexual minorities and highlight tobacco use differences within this population. Canistro et al. (2017) found that exposure to e-cigarettes could endanger human health, especially among younger consumers. Littlefield et al. (2015) noted that even though there may be harm reduction benefits associated with e-cigarettes, such as reductions in secondhand smoke, the findings in their study raises concerns about e-cigarette use among college students; thus, additional studies should be conducted in this area. Choi and Bernat (2016) recommended educating youth with asthma about the potential risks related to e-cigarette as part of a larger educational campaign on the potential risks of e-cigarette use.

By understanding the demographic, social, economic, health characteristic and behavior indicators associated with e-cigarette use, healthcare industry experts will be better able to address this emerging public health crisis with accurate claims aimed at the appropriate target audiences. The results suggest several possible policy implications and message targets:

- Because economic characteristics such as employment status and poverty status were not related to either ever or current use of e-cigarettes, raising the cost of e-cigarettes may not deter usage;

- Because younger adults were more likely to be current and ever users of e-cigarettes, target young adults with messages that using e-cigarettes is unattractive and not a good way to meet people and implement how e-cigarettes can be sold (i.e., online, stores) and to whom they can be sold (i.e., check ID for everyone under 65) could deter some.

- Because current and ever e-cigarette use was higher among persons with some college, target e-cigarette users in college towns with a message that *real* college grads do not use e-cigarettes;

- Because there may be a social component to e-cigarette use (i.e., they can be used in bars, restaurants, and other public venues that ban tobacco cigarettes), passing laws at the local level to ban the use of e-cigarettes may deter social vaping and prevent influence (i.e., require signs that say no smoking or vaping or use of e-cigarettes);

- Because second hand smoke is problematic, implement second hand smoke warning labels on packages of e-cigarettes and prohibit use in public spaces (i.e., schools and hospitals) and is harmful to developing brains of children and may complicate pregnancy;

- Because e-cigarettes typically contain nicotine which is known to be harmful, add Surgeon General's Warning: Women should not use e-cigarette during pregnancy because of the unknown risks of birth defects.

- Because flavorings for e-cigarette are attractive and help adjust to using nicotine, the FDA should ban flavorings and develop a standard list of approved ingredients for e-cigarette. This will protect the public from unknown substances in e-cigarettes and reduce nicotine poisonings.

- Because graphic warning labels in the United States has greatly reduced smoking among adolescents; increase cognitive processing of these messages that will be noticed by adults to lower e-cigarette intentions with government mandated warnings;

Because e-cigarettes can be used for ingesting nicotine, their responses to e-cigarettes, they are divided (Cahn, Z., & Siegel, 2011; Fairchild, & Bayer, 2015; Green et al., 2016; Longo et al., 2016; Wagener, Siegel, & Borrelli, 2012; Zhu et al., 2013).

Therefore, it is important for health-related organizations and interest groups to understand the prevalence of e-cigarette usage among U.S. adults as well as the factors associated with their use to influence rules to protect the public health given the dramatic increase. Many early studies of e-cigarette use were based on small, non-random samples focused on particular sub-groups; thus, results were frequently not generalizable to the U.S. adult population. This study, on the other hand, used the 2014 and 2015 NHIS to determine the prevalence of ever/past and current use of e-cigarettes among U.S. adults aged 18 years and older given a variety of factors, plus my results are generalizable to the civilian noninstitutionalized adult population of the U.S. Thus, the study addresses a gap in the literature. Furthermore, because I had a large analytic sample, I was able to include a variety of possible explanatory variables and to obtain statistically significant results. Of course, further study is recommended, and new data – particularly longitudinal data that obtain individual transitions over time – are seriously needed. In the interim, findings are directed at public health policy makers and healthcare industry experts with the hope that understanding the demographic, social, economic, health characteristic and behavior indicators associated with e-cigarette use among U.S. adults will assist them in addressing the emerging public health crisis that e-cigarettes represent, and in countering the increasing popularity of e-cigarettes with accurate claims aimed at appropriate target audiences.

Summary

The research serves to answer the question of the demographics for those adults most susceptible toward use of electronic cigarettes, based on census data from reliable

government databases. The outcomes of the research can be used as the foundational background for crystallizing an effective health policy for regulation of electronic nicotine-delivering devices, in that the regulations and policies may benefit all citizens, particularly those populations who may be targeted by the industry responsible for producing and marketing this product. Although at present there is no specific regulation or policy regarding e-cigarettes, the research serves as a resource for launching future investigations regarding the short- and long-term effects of these products – both positive (e.g. possibly smoking cessation) and negative (e.g. any harmful medical effects, such as pulmonary damage to users and those exposed to users) – which will result in policies and regulations based on scientific evidence.

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Appendices

Appendix A: 2014 NHIS Link

ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2014/samadult_layout.pdf

Appendix B: 2015 NHIS Link

ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2015/samadult_layout.pdf

Appendix C: 2015 NHIS Cancer Supplement Link

ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2015/cancerxx_layout.pdf

Appendix D: CITI Certificate

CITI PROGRAM

Completion Date 05-Jul-2017
Expiration Date 04-Jul-2020
Record ID 20910754

This is to certify that:

Tacheka Bailey

Has completed the following CITI Program course:

Basic/Refresher, Human Subjects Research Curriculum (Curriculum Group)
Group 1. Biomedical Investigators and Key Personnel (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Medical University of South Carolina

CITI