2019

E-Cigarettes: Perceived Harm among Youth in the United States

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Dissertation

May 20, 2019

Submitted in partial fulfillment of the requirements for the degree of doctor of philosophy in health science. The opinions expressed in this dissertation are the author's own and do not reflect the view of the Food and Drug Administration, the Department of Health and Human Services, or the United States government.

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We hereby certify that this dissertation, submitted by Sherbet Samuels, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirement for the degree of Doctor of Philosophy in Health Science.

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Abstract

Studies have shown e-cigarette use surged among youth, but there is limited literature about how youth perceived the harm of these products. In this dissertation study, perceived harm of e-cigarettes and e-cigarette use over time among youth in the United States was explored. The dissertation study also included assessment of associations between perceived harm and susceptibility to e-cigarette use. A subset of data from Wave 1 and Wave 2 of the Population Assessment of Tobacco and Health (PATH) study, a national longitudinal study, was utilized. The PATH study used a questionnaire to capture self-reported data from non-institutionalized participants. Data from 12,154 youth who participated in the PATH study were analyzed. The results showed perceived harm of e-cigarettes changed over time among youth and changes in perceived absolute harm of e-cigarettes coincided with changes in e-cigarette use. The results also indicated that perceived absolute harm of e-cigarettes was associated with susceptibility to use of e-cigarettes and susceptibility to use of e-cigarettes was associated with subsequent e-cigarette use. With the dissertation study, the need for integration of perceived harm of e-cigarettes into tobacco control strategies aimed at reducing e-cigarette use among youth was underscored.

Keywords: E-cigarettes, tobacco, youth, perceived harm

Acknowledgement

First and foremost, I thank God for making this achievement possible. I thank him for giving me the courage to embark on this dissertation journey and for providing me the resources, including many remarkable individuals, to help meet the challenges along the way. This experience was truly humbling and rewarding.

A special thanks to the Population Assessment of Tobacco and Health study participants and team who were fundamental to this dissertation. Thank you to my dissertation committee chair, Dr. Akiva Turner. I was fortunate to be in Winter Institute when you addressed the class and spoke about the relevance of humility and patience in the dissertation process. I am immensely grateful for your guidance and encouragement throughout this process. Thank you to my dissertation committee members, Dr. James Pann and Dr. Debra Dixon, for your expert advice and feedback throughout this process.

A special thanks to my mentors, Dr. Amber Koblitz and Dr. Mark Seaton, for your insight, relentless support, inspiration, and advice. I am fortunate that you were willing to spend countless hours sharing your knowledge with me. Thank you for believing in me, enriching my learning experience, and being awesome mentors.

Last, but definitely not least, I would like to extend my gratitude and sincere thanks to my wonderful friends and family, especially my parents, George and Zena, and my siblings, Cecelia and Howard, for their unwavering support. A very special thanks to my late grandmother, Enis Fraser, whose unapologetic love, support, and encouragement served as the bedrock of my academic pursuit. I am truly grateful for all the love and support I received throughout this dissertation journey. Thank you, thank you, and thank you!

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Chapter 1: Introduction

Introduction to the Chapter

Electronic cigarette (e-cigarette) use among youth is a major public health concern. This chapter includes the background, statement of the problem investigated, and the goals achieved. In this chapter, the significance, purpose, and need for the study are described and the research questions and hypotheses investigated are presented. In addition, definition of terms and a brief summary of the information are presented.

Background to the Problem

Emerging nicotine delivery systems, such as e-cigarettes, offer a new way for tobacco experimentation and use among youth (U.S. Department of Health and Human Services [USDHHS], 2016). E-cigarettes dominated debates about innovative tobacco product development within the tobacco harm trajectory. The long-term health effects of e-cigarettes are unknown, yet these products have increased in popularity and use among youth in the United States (US; Corey et al., 2013). Between 2017 and 2018, e-cigarette use increased among middle and high school students, by 48% and 78%, respectively (Cullen et al., 2018). In 2018, more than three million middle and high school students were e-cigarette users (Cullen et al., 2018).

The use of any tobacco product by youth raises significant public health concerns (USDHHS, 2012). Tobacco products contain nicotine, a chemical compound that causes addiction and prolongs tobacco use, which accelerates the development of chronic disease across the lifespan (USDHHS, 2012, 2014). Furthermore, nicotine exposure during adolescence may have adverse health effects on brain development and could lead

to addiction (USDHHS, 2012, 2014). Efforts to reduce youth initiation and prevalence of tobacco products are critical to public health (USDHHS, 2012, 2014).

Statement of the Problem

The adverse health consequences of tobacco use are well documented. The Centers for Disease Control and Prevention (CDC) reported that tobacco use continues to be the leading cause of preventable death in the United States (CDC, 2016b). Trends in tobacco use indicate that uses of e-cigarettes have surpassed use of conventional cigarettes among youth (Arrazola et al., 2015; National Institute on Drug Abuse [NIDA], 2014). This is problematic because longitudinal data on conventional cigarette use indicated most tobacco use behaviors begin in youth or young adulthood (USDHHS, 2012, 2014). In addition, there are concerns about how e-cigarettes are perceived by youth and the factors influencing their use. E-cigarettes are relatively new to the United States market; therefore, longitudinal data to assess how perceived harm influence e-cigarette use are scant.

The goal of this study was to explore perceived harm of e-cigarettes and e-cigarette use overtime among youth in the United States. The investigator used responses to questions from Wave 1 and Wave 2 of the Population Assessment of Tobacco and Health (PATH) study to achieve the research goal. Wave 1 data were collected September 2013 to December 2014 and Wave 2 data were collected October 2014 to October 2015 by Westat. The PATH study was sponsored by a collaborative partnership between the National Institute of Health and the U.S. Food and Drug Administration (FDA). The study data are available to the public from the Inter-university Consortium for Political and Social Research (ICPSR, 2017).

The investigator used data from the PATH study to assess changes in perceived harm of e-cigarettes overtime among youth in the United States and to determine whether perceived relative harm of e-cigarettes compared with conventional cigarettes was associated with subsequent use of e-cigarettes. The investigator assessed whether perceived harm was associated with susceptibility to use e-cigarettes and whether susceptibility to use e-cigarettes was associated with subsequent use of e-cigarettes. The results from this study are useful for developing effective tobacco control programs, public policies, and research to reduce youth initiation and use of e-cigarettes.

Relevance

E-cigarette use among youth surged in the United States at an alarming rate. These products were introduced in the United States in 2007, and by 2014, they were the most popular tobacco product among youth (Arrazola et al., 2015). This increase in e-cigarette use raised significant public health concerns due in part to the potential negative health effects and the increase risk of addiction to tobacco products during adolescence (USDHHS, 2012). In addition, e-cigarette use may serve as a gateway to use of conventional cigarettes and other tobacco products, which may potentially renormalize tobacco use (Fairchild, Bayer, & Colgrove, 2014; Rigotti, 2015). These significant concerns have underscored the need for public health actions to reduce e-cigarette use among youth.

An issue of concern was the extent to which perceived harm related to e-cigarettes influenced use of e-cigarettes among youth (Amrock, Zakhar, Zhou, & Weitzman, 2015; USDHHS, 2016). Studies indicated personal health beliefs partly determined smoking behavior. Smokers were less likely than non-smokers to believe smoking caused adverse

health consequences (Aryal & Bhatta, 2015; Murphy-Hoefer, Alder, & Higbee, 2004; Song et al., 2009). However, less is known about youth perceived harm in the context of e-cigarettes (Pepper & Brewer, 2014). Studies about perceived harm of e-cigarettes among adults showed e-cigarettes were perceived to be less harmful than conventional cigarettes (Adkison et al., 2013; Choi & Foster, 2013, 2014; Etter & Bullen, 2011; Goniewicz, Kuma, Gawron, Knysak, & Kosmider, 2013; Pearson, Richardson, Niaura, Vallone, & Abrams, 2012).

Research studies about perceived harm related to e-cigarettes among youth are scant. Ambrose et al. (2014) utilized cross-sectional data from the 2012 National Youth Tobacco Survey (N = 24,658) to assess the relative harm perceptions of e-cigarettes in comparison to conventional cigarettes among youth. The study results indicated that one out of every three student perceived e-cigarettes as less harmful than conventional cigarettes. Likewise, Amrock et al. (2015) utilized cross-sectional data from the 2012 National Youth Tobacco Survey to assess perceived harm of e-cigarettes among adolescents and found 34.2% of those who were aware of e-cigarettes perceived them as less harmful compared to conventional cigarettes. Longitudinal studies that examine perceived harm of e-cigarettes overtime among youth are scant. Furthermore, studies assessing association between perceived harm of e-cigarettes and use of e-cigarettes among youth are limited.

The dearth of research about perceived harm of e-cigarettes and subsequent use of e-cigarettes among youth may be due to various intertwined factors. These factors may include (a) the lack of longitudinal data on this topic, (b) complexity with processing and analyzing the data, (c) study associated time and cost, (d) access to data on the population

of interest, and (e) sensitivity and ethical issues with conducting research involving youth. Available data from Wave 1 and Wave 2 of the PATH study presented an opportunity to generate knowledge in this rarely explored area.

This dissertation study helped to fill this gap and expanded the literature about perceived harm related to susceptibility and use of e-cigarettes among youth in the United States. The study was framed within the theory of reasoned action. This theory was introduced by Fishbein in 1967, and later refined by Fishbein and Ajzen in 1975. The theory presents that "beliefs influence attitudes and subjective norms; these two components influence intentions; and intentions influence behavior" (Ajzen & Fishbein, 1980, p. 80). Under this framework, the dissertation study utilized secondary, de-identified data from the PATH study to examine relationships between perceived harm, intentions (e.g., susceptibility to use e-cigarettes), and e-cigarette use. The belief that was examined in the dissertation study is perceived harm related to e-cigarettes. Intention was assessed in terms of susceptibility to use e-cigarettes. The behavior of interest for the dissertation study was e-cigarette use. The dissertation study did not address subjective norms.

Elements

The dissertation study addressed two research aims with two accompanying research questions and four hypotheses, which were explored quantitatively. The first aim was to assess changes in perceived harm of e-cigarettes overtime among youth in the United States.

- Research Question 1. How has the perceived absolute harm of e-cigarettes and relative harm of e-cigarettes compared with conventional cigarettes changed between Wave 1 and Wave 2 among a cohort of youth?
- Research Question 2. Do changes in the perceived absolute harm of e-cigarettes coincide with changes in e-cigarette use status between Wave 1 and Wave 2?

The second aim was to examine the associations between perceived harm of e-cigarettes, susceptibility to use of e-cigarettes, and e-cigarette use.

- Hypothesis 1 (H_o). Perceived relative harm of e-cigarettes compared with conventional cigarettes, age, gender, and smoking status are not associated with e-cigarette use at Wave 1.
- Hypothesis 2 (H_o). Among e-cigarette non-users at Wave 1, perceived relative harm of e-cigarettes compared with conventional cigarettes, age, gender, and smoking status are not associated with subsequent use of e-cigarettes at Wave 2.
- Hypothesis 3 (H_o). Among e-cigarette non-users at Wave 1, perceived harm of e-cigarettes is not associated with susceptibility to use of e-cigarettes.
- Hypothesis 4 (H_o). Susceptibility to use of e-cigarettes at Wave 1 is not associated with use of e-cigarettes at Wave 2.

Definition of Terms

- Belief refers to an individuals' perception about consequences of a specific behavior (Azjen & Fishbein, 1980).

- Cigarette smoker refers to having tried smoking conventional cigarettes even one or two puffs.
- Conventional cigarette refers to a roll of tobacco wrapped in paper or in any substance not containing tobacco and offered to consumers as a cigarette or roll-your-own tobacco (FDA, 2018).
- E-cigarette refers to battery-operated vaporizers that simulate smoking a cigarette and may contain nicotine, but do not involve the burning of tobacco (CDC, 2014).
- E-cigarette use refers to having tried an e-cigarette even one or two times.
- Electronic nicotine delivery systems refer to products that vaporize a solution which the user inhales. In addition to nicotine, when nicotine is present, the primary constituents are propylene glycol with or without glycerol and flavoring agents (World Health Organization [WHO], 2014b).
- Not susceptible to e-cigarette use refers to a firm intention not to try an e-cigarette.
- PATH refers to the Population Assessment of Tobacco and Health survey.
- Perceived absolute harm refers to how much an individual thinks people harm themselves when they use e-cigarettes.
- Perceived relative harm refers to perception of the harmfulness of e-cigarettes compared with conventional cigarettes.
- Susceptible to e-cigarette use refers to the absence of a firm intention not to try an e-cigarette.
- Youth refer to individuals who are age 12 to 17.

Summary

The popularity and use of e-cigarettes among youth have increased. Trends in tobacco use indicate uses of e-cigarettes surpassed use of cigarettes among youth (Arrazola et al., 2015). Furthermore, between 2017 and 2018, e-cigarette use increased among middle and high school students by 48% and 78%, respectively (Cullen et al., 2018). Perceived harm in the context of e-cigarette use among youth has only been examined in a few studies, and longitudinal data on this issue are sparse. The dissertation study used longitudinal data from a cohort of youth in the United States to explore youth perceived harm related to e-cigarettes. Chapter 1 included an introduction to the study. In Chapter 2, the review of relevant literature is presented.

Chapter 2: Review of the Literature

Introduction to the Chapter

A review of relevant literature pertinent to the study concepts and theoretical framework are presented in this chapter. The chapter is organized into five sections. In the first section, the historical overview of research literature is presented. In the second section, the theoretical framework is presented. In the third section, relevant research literature about e-cigarettes is presented. In the fourth section, information that is known and unknown about e-cigarette use among youth is summarized. In the fifth section, the contributions of the study to tobacco control are discussed. This chapter also includes a brief summary of the information.

Historical Overview

E-cigarettes have epitomized an evolution in a long history of tobacco products and were the most popular prototype of the electronic nicotine delivery systems category (USDHHS, 2016). They were introduced in the United States in the 2007 and have since surged in popularity and use (USDHHS, 2016). Trends in tobacco use indicated that use of e-cigarettes have surpassed use of conventional cigarettes among youth (Arrazola et al., 2015; NIDA, 2014). E-cigarettes were promoted as a safer alternatives to conventional cigarettes (USDHHS, 2016). As such, the historical overview of conventional cigarettes is relevant to the evolution of e-cigarettes. Conventional cigarettes were a major tobacco product innovation that appeared in the United States in the early 19th century. Prior to that time, tobacco was predominantly used for chewing, pipe smoking, inhaling, and cigar smoking (USDHHS, 2000). The distinct features that separated conventional cigarettes from other forms of tobacco products had a critical role in their availability and use as a cheaper tobacco form that drove an increase in tobacco use (USDHHS, 2000).

Conventional cigarette smoking surged in the early 20th century due in part to technological advances for mass production, growth of a consumer culture, and effective national advertising and promotion (USDHHS, 2016). Early concerns about tobacco use focused on hygiene and moral issues; however, as conventional cigarette use increased, the apparent risks associated with tobacco use became apparent (USDHHS, 2016). Early studies had links between conventional cigarette smoking and adverse health conditions. One epidemiological study published in 1938 indicated smoking to be associated with an impairment of longevity (USDHHS, 2016). Additional studies demonstrating associations between smoking and overall mortality emerged in the late 1940s and early 1950s, but it was the landmark 1964 surgeon general's report on smoking and health that gave credence to the dangers of smoking (USDHHS, 2000). This report was pivotal to generating interest in efforts to stem the use of tobacco products (USDHHS, 2000). Since then, the knowledge of the health consequences of tobacco use has vastly expanded (USDHHS, 2016).

The morbidity and mortality related to tobacco use are well documented. The CDC (2016b) affirmed that conventional cigarette smoking leads to morbidity and is the leading cause of preventable death in the United States. Conventional cigarette smoking harms nearly every organ and organ system in the body and is responsible for an estimated 480,000 deaths annually in the United States (USDHHS, 2014). There is an estimation that in 2009, approximately 14 million individuals had at least one lifetime smoking-related serious medical condition, including cancer, heart attack, stroke, diabetes, or chronic obstructive pulmonary disease (Rostron, Chang, & Pechacek, 2014). In 2014, projections for the effect of smoking on health indicated that 5.6 million youth

currently age 0 to 17 will die prematurely from smoking-related illnesses, and the annual smoking-attributable economic cost exceeded $280 billion (USDHHS, 2014).

The primary active ingredient in tobacco products is nicotine, a chemical compound that causes addiction (USDHHS, 2012, 2014). The various vehicles used for nicotine delivery have distinct features and social susceptibilities. Nicotine delivery was crucial to the development of conventional cigarettes in the 20th century and is a major component of the diverse class of e-cigarettes (USDHHS, 2016). Use of any tobacco products by youth raised significant concerns because in addition to the significant adverse health outcomes, addiction to tobacco products may occur in those who experiment or start using tobacco products in adolescence (USDHHS, 2012). "Nicotine exposure during adolescence, a critical window for brain development, may have lasting adverse consequences for brain development" (USDHHS, 2014, p. 37). Because the majority of adult smokers reported that they started smoking during youth or young adulthood, efforts to reduce youth initiation and prevalence of tobacco products are critical to public health (USDHHS, 2012, 2014). Mitigating youth use of e-cigarette is a major public health priority (CDC, 2016a).

The brain continues to develop and undergo changes during adolescence. Introducing drugs during this time period may have long-lasting effect (USDHHS, 2016). According to NIDA (2018b), people often use drugs to feel good, feel better, do better, or due to curiosity and social pressure. The prefrontal cortex, the brain's rational region, is still maturing during adolescence, which places them at increased risk for making poor decisions (USDHHS, 2016). Although the initial decision to use drugs were usually voluntary, continued use could impair self-control, which is the hallmark of addiction

(NIDA, 2018b). Biological and environmental factors can increase the risk of addiction. These factors included genes, stage of development, gender, ethnicity, family, school, and neighborhood (NIDA, 2018b).

Illicit Substance Use

Understanding the extent of illicit substance use among youth may provide insight into e-cigarette use. Monitoring the Future tracked various illicit substance use and related factors among eighth-, tenth-, and 12th-grade students in the United States. These substances included marijuana, inhalants, lysergic acid diethylamide (LSD), cocaine, crack, amphetamines, methamphetamine, heroin, narcotics, hallucinogens, ecstasy, Molly, alcohol, tobacco products, and steroids (Johnston et al., 2019). Johnston et al. (2019) found the factors related to illicit substance use were specific to each substance and perceived benefits, perceived adverse outcomes, peer norms, and availability were associated with use. An analysis of the Monitoring the Future national survey results from 1975 to 2018 showed that since 2011, the proportion of students who used illicit substances remained between 48% to 50% (Johnston et al., 2019). However, prior to 2011, distinct fluctuations in the trends in illicit substance use were noted. Between 1975 and 1981, illicit substance use among students increased from 55% to 66% and between 1981 and 1992 decreased from 66% to 41%. However, between 1992 and 1999 illicit substance use increased from 41% to 55% and between 1999 and 2009 decreased from 55% to 47%. Marijuana was the most used illicit substance among students (Johnston et al., 2019). Vaping of various substances were also monitored. The Monitoring the Future survey on vaping was revised in 2017 to capture vaping of specific substances such as nicotine (e.g., e-cigarettes). Between 2017 and 2018, nicotine vaping surged 10

percentage points, which was the largest recorded increase in any specific substance use in the 44 years of the Monitoring the Future survey (Johnston et al., 2019). According to Johnston et al. (2019), the nicotine vaping prevalence rate among students in the 12th-grade was 30%.

Several researchers have reported on interventions aimed at reducing substance use among youth. Cuijpers (2002) conducted a systematic review of the literature to identify characteristics of effective drug prevention programs. The findings showed most programs often contained the following elements: have proven effects, used interactive delivery methods, used social influence model, focused on norms, included commitment and intention not to use, added community interventions, used peer leaders, and added life skills. Despite these key features, it was difficult to ascertain effective characteristics of drug prevention programs due to variability in interventions, formats, targets, targeted substances, age groups, and theoretical frameworks (Cuijpers, 2002).

Edalati and Conrod (2019) evaluated a personality-targeted interventions program with high-risk adolescents. The program was embedded in the community and offered substance use intervention at school levels to high-risk adolescents who otherwise may not have had access to these types of programs. The findings indicated targeting risk factors, such as anxiety, impulsivity, sensation seeking, hopelessness, and sensitivity, reduced rates of alcohol and illicit drug use and substance-related harms by approximately 50%, and the effects lasted for up to 3 years (Edalati & Conrod, 2019).

Das, Salam, Arshad, Finkelstein, and Bhutta (2016) conducted a systematic review of the literature on intervention for substance abuse in adolescents and found the most evaluated programs were school-based. The findings indicated different effective

approaches based on the program targets. Interventions for tobacco use or smoking included school-based prevention programs, family-based interventions, and mass media campaigns. Interventions for drug abuse, including interventions against drugs and cannabis use, included school-based interventions based on combination approaches focusing on social competence and social influences. The researchers noted a lack of data on the deferential effects of programs based on gender or contextual factors. In addition, there was a lack of data on sustainability and long-term effect of substance abuse programs. Furthermore, the effectiveness of Internet-based interventions, policy initiatives, and incentives were unknown, and there was a lack of standardized measures for interventions and outcomes (Das et al., 2016).

NIDA advocated for research-based prevention programs at the parental, school, and community levels that enhance protective factors and reverse or reduce risk factors (NIDA, 2018b). According to NIDA, research indicated protective factors included good self-control, parental monitoring and support, positive relationships, good grades, school anti-drug policies, and neighborhood resources. On the other hand, risk factors included aggressive behavior in childhood, lack of parental supervision, poor social skills, drug experimentation, availability of drugs in schools, and community poverty (NIDA, 2018b). NIDA's drug abuse prevention programs for children and adolescents included universal, selective, or indicated approaches, depending on the target audience (NIDA, 2018b). NIDA's universal programs were designed to address common risk and protective factors for all children in a specific setting (e.g., school or community). The selective programs were intended to be used to target groups of children and adolescents who have specific factors that increased their risk of drug use. The indicated programs

were intended to be used to target youth who have already started using drugs (NIDA, 2018b). Common features among the various substance abuse programs for youth included targeted interventions.

Theoretical Framework

The theory of reasoned action is a useful framework for identifying key behavioral and normative beliefs for which targeted interventions can be designed to change intentions and behavior (Glanz, Lewis, & Rimer, 1997). The theory of reasoned action presents a framework for assessing relationships among beliefs, attitudes, norms, intentions and behavior (Ajzen & Fishbein, 1980). With the PATH study, aspects of these constructs were captured in the context of tobacco use. The PATH study presents data on factors influencing tobacco use, including data on beliefs, such as harm perception, susceptibility to use e-cigarettes, and e-cigarette use (ICPSR, 2017).

The theory of reasoned action contends that individuals consider the implications of their actions before they decide whether or not to part take in a given behavior. The theory presents the idea that intention is the immediate determinant of an action, meaning intention predicts behavior (Ajzen & Fishbein, 1980). According to Ajzen and Fishbein (1980), intention is the function of attitudes and norms. The authors postulated that attitudes are a function of beliefs. They explained that behavioral beliefs are the beliefs underlying a person's attitudes towards a behavior, whereas normative beliefs are the beliefs that formulate a person's perceived social norms (Ajzen & Fishbein, 1980).

Several health researchers have used the theory of reasoned action (Glanz et al., 1997). Gimenez-Garcia et al. (2013) assessed the influence of culture for perceived risk of HIV infection and condom use among young people with Mexican and Spanish origin.

The study was guided by the theory of reasoned action. The study variables included (a) the perception of HIV risk and fear of infection, (b) the perception of high-risk groups of becoming infected, (c) the perceived severity of HIV infection, (d) the perceived reliability of the use of condoms, (e) the barriers of condom use as a preventive method, (f) the notion of self-efficacy in some situations related to condom use, (h) the behavioral intention of using condom in a future sexual situation, and (i) the use of condoms in different practices (vaginal, anal, and oral sex) and situations (casual partner, steady partner, and after using drugs). The researchers found differences between the risk behavior profiles based on origin or gender. The findings showed Mexican participants exhibited higher levels of perceived risk or severity of HIV while Spanish participants exhibited higher levels of the fear of HIV. In addition, the researchers found predictors of condom use differed depending on origin and gender. The authors recommended considering cultural differences when developing strategies to prevent HIV transmission (Gimenez-Garcia et al., 2013).

Constructs from the theory of reasoned action were used by researchers to examine behavioral beliefs and normative beliefs associated with the use of waterpipes to smoke tobacco. The researchers found that current smoking status, including use of waterpipes, predicted smoking intentions (Noonan & Kulbok, 2012). Martinasek, Haddad, Weldon, and Barnett (2017) explored behavioral beliefs, subjective norms, attitudes, and behavioral intention among smokers of waterpipe tobacco. The study was also guided by the theory of reasoned action. The participants included students from a liberal arts university in Florida. The data were collected via email with the use of a cross-sectional survey. Participants were asked to report their beliefs and opinions using

a seven-point Likert scale ranging from *extremely unlikely to extremely likely* related to (a) physical, (b) mental, (c) social, (d) recreational, (e) cultural, and (f) health. The health belief items included perceived harm. The researchers also measured attitudes towards waterpipe smoking, subjective norms, and intentions to smoke a hookah. The researchers found associations between smoking behavior and the constructs from the theory of reasoned action. The beliefs reported by smokers were more strongly related to attitudes towards hookah than with subjective norms (Martinasek et al., 2017).

In another study, researchers applied the theory of reasoned action to examine the influence of beliefs about the addictiveness of e-cigarettes, e-cigarette advertising appeal, and tobacco use behaviors to predict behavioral intention to use an e-cigarette in the near future (Trumbo & Kim, 2015). Beliefs about the addictiveness of e-cigarettes were measured in terms of whether e-cigarettes were less addictive than conventional cigarettes. Appeal of e-cigarette advertising was measured in terms of whether a product and advertisement was enjoyable, likable, or appealing. Attitudes were measured in terms of having positive assessments of e-cigarettes as a new form of smoking and norms were measured in terms of positive perception that significant others would approve of e-cigarette use. The researchers found beliefs that e-cigarettes were not as addictive as conventional cigarettes were independently associated with intention to use e-cigarettes. In this study, 32% of participants believed or strongly believed that e-cigarettes were not as addictive as conventional cigarettes. The researchers also found significant associations between appeal, attitudes, and norms. Furthermore, they found that attitudes and norms were associated with intentions (Trumbo & Kim, 2015).

The predictive value of the theory of reasoned action was examined by Sheppard, Hartwich, and Warshaw (1988). They conducted two meta-analyses of studies, which utilized the theory of reasoned action, to investigate the effectiveness of this model. These studies were conducted across a wide range of contexts, including smoking cigarettes, donating blood, and use of birth control pills. One meta-analysis included 87 studies of the relationship between intention and behavior across different domains. The other meta-analysis included 87 separate studies of the relationship between attitude, subjective norm, and intention. The meta-analyses were used to support the predictive value of the theory of reasoned action and showed that the predictive utility of the model remained strong across conditions (Sheppard et al., 1988). Cooke and French (2008) also conducted a meta-analysis of studies utilizing the theory of reasoned action and the theory of planned behavior in the domain of screening attendance. The researchers examined the strength of the relationships between (a) attitude and intention, (b) subjective norm and intention, (c) behavior control and intention, (d) intention and behavior, and (e) perceived behavior control and behavior. Thirty-three studies were included in the analysis. The researchers found that attitudes had a large-sized relationship with intentions and subjective norms had a medium-sized relationship with intentions across studies (Cooke & French, 2008).

Limitations of the theory of reasoned action included factors not captured under this theoretical framework. The focus of the underlying concepts of the theory of reasoned action is on attitudes towards a behavior and subjective norms to understand and predict behavior intention (Ajzen & Fishbein, 1980). This theoretical framework does not capture personality characteristics, demographic variables, social roles, or goal

intentions (Ajzen & Fishbein, 1980). Furthermore, factors involving choices among alternatives or perceived control over a behavior are outside the limits of this theory (Ajzen & Fishbein, 1980; Glanz et al., 1997; Sheppard et al., 1988). The theory of reasoned action is best used with prospective study designs as cross-sectional designs may not discern sequence of events (Glanz et al., 1997; Sheppard et al., 1988).

Research Literature Specific to the Topic

E-Cigarette Attributes

E-cigarettes were distinguishable from conventional cigarettes in that conventional cigarettes burned the tobacco leaf, whereas e-cigarettes vaporized liquid that contains nicotine for the purposes of inhaling (WHO, 2014a). Although product attributes, design, and ingredients may vary by manufacturer, e-cigarettes typically consisted of an integrated structure containing a cartridge filled with a humectant carrier (such as propylene glycol or glycerin) mixed with varying concentrations of chemicals with nicotine or non-nicotine solution and a heating element powered by battery, which turned the liquid substance into an aerosol that was inhaled by the user (Cobb, Byron, Abrams, & Shields, 2010; FDA, 2015). Most e-cigarettes resembled conventional cigarettes, cigars, or pipes, but some looked like everyday items, such as pens and USB memory sticks (FDA, 2015; WHO, 2014b). Zhu et al. (2014) conducted Internet searches for e-cigarettes on English-language Web sites and found over 460 brands and over 7,760 unique flavors of e-cigarettes on the market. The most common ingredients listed on e-cigarette product labels were nicotine, propylene glycol, vegetable glycerine or glycerol, flavoring, and water (Zhu et al., 2014).

Chemistry data for e-cigarettes showed variations in the levels of nicotine. The data also showed variations in the levels of other harmful or potentially harmful constituents (FDA, 2015; WHO, 2014b). The FDA's analysis of two popular brands of e-cigarettes found detectable levels of known carcinogens and toxic chemicals (FDA, 2014). Goniewicz, Hajek, and McRobbie (2014) analyzed vapors from 12 brands of e-cigarettes and found some toxic substances, but the levels were nine to 450 times lower than in cigarette smoke and were comparable to levels found in other nicotine products. Cheng (2014) performed a systematic review of the literature related to the chemistry of e-cigarettes and found various substances known to be toxic or carcinogenic were in the aerosols, cartridges, and emissions of e-cigarettes. Cheng (2014) found the levels of constituents, such as nicotine, tobacco-specific nitrosamines, aldehydes, metals, volatile organic compounds, flavors, solvent carriers and tobacco alkaloids, varied across products.

Other researchers have also showed variations in nicotine concentration in e-cigarettes. In one study, researchers found that some e-cigarettes labeled as nicotine free contained detectable levels of nicotine. The researchers also found nicotine concentration in e-cigarettes sold in the United States ranged from 0 to 36.6 mg/mL of nicotine (Goniewicz et al., 2015). Goniewicz, Hajek, et al. (2014) conducted a study with five popular brands of e-cigarettes and examined the nicotine content in the cartridges and vapor. They found variations of up to 12% relative standard deviation between different batches of the same brand. In other words, they also found that nicotine in the vapor was not related to variation in nicotine content in the e-liquid. Goniewicz et al. (2013) also conducted a study of 16 e-cigarette brands that were popular in the Polish, United

Kingdom, and United States market. Likewise, there were variations in nicotine vaporization. The nicotine in the vapor produced by 20 series of 15 puffs ranged from 0.5 mg to 15.4 mg and was not related to the nicotine content (Goniewicz et al., 2013).

E-Cigarette History, Claims, and Uses

The concept for e-cigarettes emerged in the early 1960s. The first e-cigarette patent was filed in 1963 for "a smokeless non-tobacco cigarette" (Gilbert, 1963). The inventor described this product as “replacing burning tobacco and paper with heated, moist, flavored air” (Gilbert, 1963, p. 1). Modern e-cigarettes were invented by Lik who obtained an international patent in 2007 for an electronic atomization cigarette containing only nicotine without tar (Lik, 2007).

E-cigarettes were the most popular prototype of a broader class of emerging tobacco products referred to as electronic nicotine delivery systems (WHO, 2014b). These products delivered nicotine and other substances to the respiratory system (World Health Organization, 2009). Although e-cigarettes were a subset of electronic nicotine delivery systems, the terms e-cigarette and electronic nicotine delivery systems have been used interchangeably. Other terms, including e-cig, vape, vaper, and vaping, have also been used to refer to e-cigarettes (Zhu et al., 2014).

E-cigarettes entered into the United States market in 2007 (Pauly, Li, & Barry, 2007). Since then, the products have surged in popularity (Zhu et al., 2014). E-cigarettes were often sold as either a disposable product or as a refillable product. With the disposable versions, the unit was discarded after the liquid solution was expended. The refillable products were designed to allow the liquid to be replenished (Zhu et al., 2014).

One vital tool used to influence behavior was marketing. Researchers have shown associations between marketing and smoking initiation behaviors (USDHHS, 2012). The potential for marketing to influence e-cigarette initiation and use is a public health concern (USDHHS, 2016). In one study, researchers examined the persuasive themes in tobacco advertisement and found e-cigarette advertisements highlighted quality and price as well as comparative advantages over conventional cigarettes (Banerjee, Shuk, Greene, & Ostroff, 2015). Richardson, Ganz, Stalgaitis, Abrams, and Vallone (2014) found magazines advertisements for e-cigarettes often depicted health- and non-health- related themes, including sexual, romantic, and social content.

Marketing claims for electronic nicotine delivery systems, including e-cigarettes, varied among manufacturers, but the products were promoted as a safer alternative to conventional cigarettes (Grana, Glantz, & Ling, 2011). Zhu et al. (2014) found various claims about e-cigarettes on the Internet. These included claims such as e-cigarettes were (a) less harmful than conventional cigarettes, (b) a substitute for places where one cannot smoke, (c) cheaper than cigarettes, and (d) effective for smoking cessation. The products have been featured in movies, used by prominent celebrities on late night shows, featured on talk shows, and included in gift bags for the 2010 Grammy attendees (Grana et al., 2011). These research studies were conducted prior to the issuance of FDA's 2016 deeming rule, which extended FDA's regulatory authorities to other tobacco products, including e-cigarettes (FDA, 2018).

Various reasons have been cited for using tobacco products. Researchers have found that curiosity was one of the drivers for using conventional cigarettes (Nadora et al., 2014; Pierce, Distefan, Kaplan, & Gilpin, 2005). Likewise, curiosity has been cited

as a reason for using e-cigarettes (Biener, Song, Sutfin, Sangler, & Wolfson, 2015). Li, Newcombe, and Walton (2015) examined adults in New Zealand and found curiosity and desire to quit smoking as the most common reasons cited for using e-cigarettes. Etter and Bullen (2011) conducted an online survey in English and French to assess e-cigarette users (a) profile, (b) utilization patterns, (c) satisfaction, and (d) perceived effects. The study included 3,587 participants over the age of 18 who were self-selected visitors to Web sites dedicated to e-cigarettes. The participants reported various reasons for using e-cigarettes. The researchers found that one of the main reasons cited for using e-cigarettes was due to perception that e-cigarettes were less toxic than other tobacco products (84%). Other reasons identified for using e-cigarettes were (a) to deal with tobacco cravings (79%), (b) to address tobacco withdrawal symptoms (69%), (c) to quit smoking or avoid smoking relapse (77%), (d) lower cost than smoking (57%), and (e) used in situations when smoking was prohibited (39%) (Etter & Bullen, 2011). Pepper and Brewer (2014) conducted a systematic review of the literature on electronic nicotine delivery systems, including e-cigarettes, and found similar reasons cited for using these products, which included (a) quitting smoking, (b) using a product that was healthier than conventional cigarettes, and (c) to avoid smoking restrictions.

Prevalence of E-Cigarette Use among Youth

The appeal of e-cigarettes among youth raised serious concerns (Fairchild et al., 2014). Researchers indicated an increase in use of e-cigarettes by adolescents in the United States (Caroll Chapman & Wu, 2014). Between 2011 and 2013, e-cigarette use among never-smoking youth increased threefold from 79,000 in 2011 to more than 263,000 in 2013 (Bunnell et al., 2015). Data from the 2011 to 2014 National Youth

Tobacco Survey showed e-cigarettes were the most commonly used tobacco product among youth (Arrazola et al., 2015). In 2014, approximately two million high school students were e-cigarette users (Arrazola et al., 2015). Between 2017 and 2018, e-cigarette use increased by 78% (11.7% to 20.8%) among high school students and 48% (3.3% to 4.9%) among middle school students (Cullen et al., 2018). In 2018, over three million middle and high school students were e-cigarette users (Cullen et al., 2018).

Other researchers have also reported that a notable proportion of youth were using e-cigarettes. The 2015 National Youth Tobacco Survey estimated that approximately 27.1% of adolescents in the United States have tried e-cigarettes, which represents approximately 7,260,500 individuals (USDHHS, 2016). The Monitoring the Future 2014 Survey results showed that among eighth-, tenth-, and 12th-grade students, past month use of e-cigarettes was 8.7%, 16.2%, and 17.1%, respectively (NIDA, 2014). In 2014, 13.4% of high school students reported ever use of e-cigarettes (Arrazola et al., 2015). Data from the 2014 National Youth Tobacco Survey analyzed by the CDC and the FDA showed that among high school students who were current users of e-cigarettes, 15.5% used the product on 20 or more of the preceding 30 days (Neff et al., 2015).

The types of adolescent using e-cigarettes were described by researchers who found that many have never smoked conventional cigarettes. Corey et al. (2013) found that between 2011 and 2012, lifetime e-cigarette use among youth doubled from 3.3% to 6.8%, and current use doubled from 1.1% to 2.1%. The researchers also found that 9.3% of lifetime and 20.3% of past-month users had never smoked conventional cigarettes. Similarly, Camenga et al. (2014) found that from February 2010 to June 2011, past month use of e-cigarettes doubled among high school students, and a notable proportion

(12.5% in February 2010, 17.2% in October 2010, and 16.1% in June 2011) of current e-cigarette users never smoked conventional cigarettes. Barrington-Trimis et al. (2015) assessed the role of e-cigarette psychological factors on risk of e-cigarette or cigarette use in 11th- and 12th- grade students in the Southern California Children's Health Study. They found that 40.5% of current e-cigarette users never smoked a conventional cigarette.

Health Consequences

The health consequences of tobacco use are well documented, but the net public health effect of e-cigarette use is unknown (Callahan-Lyon, 2014; Durmowicz, 2014). Burn injuries and explosions related to e-cigarettes have been reported in the literature (Brownson et al., 2016; Chen, 2013; Corey, Chang, & Rostron, 2018; Durmowicz, Rudy, & Chen, 2016; McKenna, 2017; Rudy & Durmowicz, 2016; Toy et al., 2017; Walsh, Sheikh, Johal, & Khwaja, 2016). Similarly, serious adverse events related to e-cigarettes, including pulmonary and cardiac issues, have been cited in the literature (Alzahrani, Pena, Temsgen, & Glant, 2018; Chen, 2013; Kaur, Pinkston, Mclemore, Dorsey, & Batra, 2018; Liu et al., 2018).

Considerable attention has been given to the potential benefits and risk of e-cigarettes in the absence of evidence relating to the long-term health consequences of these products. To project the potential health effects, researchers have examined the constituents in e-cigarettes. However, the dynamic and diverse compositions of e-cigarettes made assessing the potential health effects challenging (USDHHS, 2016).

Nicotine exposure. Nicotine is the main chemical compound that causes and sustains the addicting effects of tobacco products (USDHHS, 2014). Due to the paucity

of long-term e-cigarette data, evidence from other nicotine products offers a useful analogy of the potential health effects (USDHHS, 2016). Nicotine from e-cigarettes affected the brain similarly to nicotine from other sources (NIDA, 2018a). Nicotine from e-cigarettes was absorbed into the bloodstream from the lungs and activated the brain's reward circuits. Nicotine increased dopamine levels, which reinforced reward behaviors that motivated some individuals to continue to use nicotine (NIDA, 2018a; USDHHS, 2016).

Most tobacco use begins in childhood and adolescence, and approximately 88% of adult smokers reported that they initiated use of conventional cigarettes by the age of 18 (USDHHS, 2012). In youth, nicotine exposure is of major concern because of the potential for addiction in this population (USDHHS, 2012). In comparison with adults, nicotine has more severe and durable effects on the brains of youth (USDHHS, 2016). In addition, nicotine exposure during youth may affect cognitive function and the developing brain (USDHHS, 2014).

During youth and young adulthood, the brain undergoes major neurobiological development. Yuan, Cross, Loughlin, and Leslie (2015) highlighted clinical and preclinical data and examined the distinct neurobiological and nicotine sensitivity of the adolescent's brain. They noted that during adolescence, a reorganization of the structural and functional brain regions occur. These reorganizations are necessary for mature cognitive and executive function. Yuan et al. (2015) also reported that nicotine exposure may alter adolescent brain and signal addiction pathways. In addition, chronic exposure to nicotine produced alterations in neurochemistry and behavior that are different for adolescence compared to adults (Yuan et al., 2015).

In preclinical studies, researchers found that chronic nicotine use in adolescence compared with adults enhanced dopamine-mediated behaviors, increased locomotor activity, and enhanced sensitivity and susceptibility to other drugs, including acquisition of cocaine, methamphetamine, and alcohol self-administration (Yuan et al., 2015). In addition, chronic nicotine use in adolescence reduced cognitive function, including decreased attention span, increased impulsivity, altered emotional responses, and enhanced anxiety and fear (Yuan et al., 2015). Weiss et al. (2008) examined the association between nicotine acetylcholine receptor (nAChR) genetic variants and nicotine dependency in three cohorts of long-term smokers. These smokers were of European origins and were recruited in Utah, Wisconsin, and by the National Heart, Lung, and Blood Institute (NHLBI) Lung Health Study researchers. The researchers found a link among early nicotine exposure, common genes related to the severity of addiction (CHRNA5-A3-B4 haplotypes), and adult nicotine addiction.

The risk of nicotine addiction depends on the dose and method of delivery (USDHHS, 2016). E-cigarettes offer a new method for nicotine delivery. Addiction can begin in individuals who experimented with tobacco use during teenage years (USDHHS, 2012). Adolescents appear to be vulnerable to the adverse effect of nicotine on the central nervous system (USDHHS, 2012). Furthermore, in one health report, there were conclusions that "nicotine exposure during adolescence, a critical window for brain development, may have lasting adverse consequences for brain development" (USDHHS, 2014 p. 37).

Smoking cessation. Studies on the efficacy of e-cigarettes as a smoking cessation tool had mixed results. Some studies showed that e-cigarettes may aid with

smoking cessation. In one study, researchers found that smokers who used e-cigarettes substantially decreased cigarette smoking (Polosa et al., 2011). In a longitudinal study of adults in two United States metropolitan areas, researchers found that smokers who used e-cigarettes daily for at least one month were six times more likely to report that they quit smoking compared to smokers who did not use e-cigarettes or only used e-cigarettes once or twice (Biener & Hargraves, 2015). In randomized studies conducted with e-cigarettes, there were also indications for use of the products for smoking cessation. In a 12-month randomized control trial consisting of 300 smokers not intending to quit smoking, it was found that the use of e-cigarettes reduced conventional cigarette consumption in participants at Week 12 and Week 52 by 22.3% and 10.3%, respectively. The researchers also found the use of e-cigarettes resulted in complete abstinence from smoking at Week 12 and Week 52 by 10.7 % and 8.7%, respectively, of participants (Caponnetto et al., 2013). In a randomized control study of 657 participants in New Zealand, there was an assessment for whether e-cigarettes with nicotine were more effective than patches or placebo e-cigarettes for smoking cessation. The researchers found 13 weeks use of e-cigarettes that contained nicotine resulted in increased smoking abstinence at Month 6 compared with e-cigarette patches or placebo (Bullen et al., 2013).

Other researchers have found smokers who used e-cigarettes were no more likely to quit smoking than those who did not use e-cigarettes (Adkison et al., 2013; Vikerman, Carpenter, Altman, Nash, & Zbikowski, 2013). Adkison et al. (2013) surveyed current and former smokers in four English-speaking countries. The researchers found trial and use of electronic nicotine delivery systems were associated with smoking status. Electronic nicotine delivery system users were more likely to reduce the number of

conventional cigarettes smoked per day than non-users, but quitting smoking did not differ between electronic nicotine delivery system users compared with non-users. Vickerman et al. (2013) analyzed data from 2,758 callers to six state tobacco quit-lines 7 months after quit-line enrollment. Approximately 31% of callers seeking cessation services had ever tried e-cigarettes, and approximately 9% were current users of e-cigarettes. The researchers found e-cigarette users were less likely than those who had never used e-cigarettes to have quit tobacco use. The U.S. Preventative Services Task Force (2015) reviewed the evidence on smoking cessation and concluded that the "current evidence is insufficient to recommend electronic nicotine delivery systems for tobacco cessation in adults, including pregnant women" (p. 1). These research studies were conducted prior to the issuance of FDA's 2016 deeming rule, which extended FDA's regulatory authorities to other tobacco products, including e-cigarettes (FDA, 2018).

Initiating use of conventional cigarettes. The uptake of e-cigarettes among never-smoking youth has sparked concerns about e-cigarette use as a gateway to addiction and renormalization of smoking (Fairchild et al., 2014; Rigotti, 2015). One researcher found youth who were ever e-cigarette users (43.9%) were more likely to indicate intentions to smoke conventional cigarettes than youth who were never-e-cigarette users (21.5%; Bunnell et al., 2015). Leventhal et al. (2015) conducted a repeated-measures prospective observational study to examine e-cigarette and combustible tobacco use among a cohort of 2,530 ninth graders attending 10 California high schools. Measures were assessed at baseline, at six-month follow-up, and at 12-month follow-up. At baseline, all students were non-smokers, and 222 (8.8%) had ever

used an e-cigarette. Ever users of e-cigarettes were more likely to report past six-month use of any combustible tobacco products than never-e-cigarette users at the six-month follow-up (30.7% vs 8.1%) and at the 12 month follow-up (25.2% vs. 9.3%).

Findings from other studies also indicated e-cigarette use may lead to initiation of other tobacco products. Barrington-Trimis et al. (2016) followed a cohort of 11th and 12th graders in Southern California to examine whether e-cigarette use increased the risk of conventional cigarette initiation. The study included 146 never-smoking-e-cigarette users and 152 never-smoking, never-e-cigarette users at baseline. Follow-up assessment occurred approximately 16 months from baseline. The researchers found at follow-up around 40% of e-cigarette users and around 10% of never-e-cigarette users initiated cigarette smoking. Primack, Soneji, Stoolmiller, Fine, and Sargent (2015) also found in a cohort of youth and young adults, baseline e-cigarette use was associated with progression to conventional cigarette smoking. Likewise, Wills et al. (2017) followed a cohort of students in Hawaii who were in Grades 9 and 10 and found students who used e-cigarettes at baseline were three times more likely to smoke conventional cigarettes one year later.

Relevant Concepts

Perceived harm. Perception of the positive and negative consequences of an action is a key predictor of behavioral intentions and future behavior (Azjen & Fishbein, 1980; Glanz et al., 1997). Risk perception has been studied in the context of conventional cigarette smoking and may be relevant to e-cigarettes use. Researchers have established a relationship between risk perception and smoking behavior. In a longitudinal study of 395 high school students in northern California, it was found that

smoking behavior was directly related to perception of smoking risk and benefits. Those who perceived low long-term risks related to smoking behavior were 3.64 times more likely to initiate tobacco use than those who perceived high long-term risks related to smoking behavior (Song et al., 2009). Murphy-Hoefer et al. (2004) surveyed 1,020 college students to determine perceived risk of conventional cigarette smoking and addiction to nicotine. The results of the study showed smokers tended to underestimate the risks associated with smoking compared with non-smokers (Murphy-Hoefer et al., 2004). Smokers (32%) were less likely than non-smokers (60%) to believe health risks were associated with smoking on the weekends or a couple days per week (Murphy-Hoefer et al., 2004).

The general United States adult population believed e-cigarettes were less harmful than conventional cigarettes (USDHHS, 2016). Several researchers found e-cigarette users perceived e-cigarettes to be less harmful than conventional cigarettes (Adkison et al., 2013; Ambrose et al., 2014; Amrock et al., 2015; Choi & Foster, 2013; Choi & Foster, 2014; Etter & Bullen, 2011; Goniewicz et al., 2013; Pepper & Brewer, 2014; Pearson et al., 2012). Most studies of e-cigarette harm perception included adults. In a population-based prospective cohort study of 2,624 Midwestern young adults aged 20 to 28, 53% of those who were aware of e-cigarettes agreed e-cigarettes were less harmful than conventional cigarettes, and 26% agreed e-cigarettes were less addictive than conventional cigarettes (Choi & Forster, 2013). Another researcher analyzed data from a national online survey of adults aged 18 years and older and the Legacy Longitudinal Smoker Cohort, which included adult smokers, aged 18 to 49. The researchers found among smokers who were aware of electronic nicotine delivery systems, 70.6% of

participants in the online survey and 84.7% of participants in the Legacy Longitudinal Smoker Cohort believed electronic nicotine delivery systems were less harmful than conventional cigarettes (Pearson et al., 2012). In a qualitative study, researchers investigated perceived harm related to e-cigarettes in a focus group with young adults (18-26 years old) from the Minneapolis-St. Paul Minnesota metropolitan area who had never tried e-cigarettes (Choi, Fabian, Mottey, Corbett, & Forster, 2012). Participants expressed mixed beliefs related to the harmfulness of e-cigarettes compared with conventional cigarettes (Choi et al., 2012).

Studies in which youth's perceived harm of e-cigarette use were assessed are limited. These studies primarily involved use of cross-sectional surveys. Data from the Monitoring the Future Survey showed 14.2% of 12th-grade students viewed e-cigarettes as harmful (NIDA, 2014). In an exploratory study consisting of 104 male high school students, researchers found e-cigarette use behavior was strongly associated with perceived risks of e-cigarettes. Furthermore, the researchers found e-cigarettes were perceived as less risky compared with conventional cigarettes (Chaffee et al., 2015). Other researchers also indicated similar findings among youth. Ambrose et al. (2014) utilized data from the 2012 National Youth Tobacco Survey (N = 24,658) to assess the relative perceived harm of e-cigarettes compared with conventional cigarettes among youth and found one out of every three students perceived e-cigarettes as less harmful than conventional cigarettes. Likewise, Amrock et al. (2015) utilized data from the 2012 National Youth Tobacco Survey to assess perceived harm of e-cigarettes among adolescents and found 34.2% of those who were aware of e-cigarettes perceived e-cigarettes as less harmful compared to conventional cigarettes. The researchers also

found more males (38.8%) than females (29.4%) perceived e-cigarettes as less harmful than conventional cigarettes.

Susceptibility. The theory of reasoned action presents that a predictor of future behavior is intention to perform the behavior (Azjen & Fishbein, 1980). Susceptibility may signal the prospect of future experimentation with tobacco products (Pierce, Choi, Gilpin, Farkas, & Merrit, 1996). In one longitudinal study, researchers found susceptibility was a strong independent predictor of subsequent conventional cigarette use. Susceptibility to conventional cigarette use was measured by the following questions: "Do you think that you will try a cigarette soon?" "Do you think that you will be smoking cigarettes 1 year from now?" and "If one of your best friends were to offer you a cigarette, would you smoke it?" (Pierce et al., 1996).

The 2015 National Youth Tobacco Survey indicated about 38.4% of high school students and 32.1% of middle school students in the United States were susceptible to future e-cigarette use (USDDHS, 2016). However, there is limited national longitudinal data that capture susceptibility in the context of e-cigarette use. In one study, researchers utilized longitudinal data from middle and high school students in Connecticut to examine whether susceptibility predicted subsequent e-cigarette use. Susceptibility was measured by the following questions: "If one of your best friends offered you an e-cigarette, would you smoke it?" and "Do you think that in the future you might experiment with e-cigarettes?" E-cigarette use was assessed at baseline and follow-up 6 months later (Bold, Kong, Cavallo, Camega, & Krishnan-Sarin, 2016). The researchers found susceptibility was a strong predictor of e-cigarette initiation at Month 6 (*OR* =

4.27, 95% CI [3.12–5.85]) and also a strong predictor of past 30-day e-cigarette use (*OR* = 5.10, 95% CI [3.38–7.68]; Bold et al., 2016).

Summary of the Known and Unknown about the Topic

Tobacco use led to preventable diseases and premature death (USDHHS, 2014). E-cigarettes were the most popular prototype of the electronic nicotine delivery systems category, and most e-cigarettes contained nicotine and other harmful or potentially harmful constituents (FDA, 2015; WHO, 2014a). These products were promoted as a safer alternative to conventional cigarettes (Grana et al., 2011). Use of e-cigarette has increased among youth (Carroll Chapman & Wu, 2014). The appeal of these products to youth raised significant public health concerns (Fairchild et al., 2014). Results from longitudinal studies indicated an association between e-cigarette use and initiation of other tobacco products (Barrington-Trimis et al., 2016; Leventhal et al., 2015; Primack et al., 2015; Wills et al., 2017).

Most researchers who examine youth's perceived harm of e-cigarettes assessed the perceived relative harmfulness of e-cigarettes compared with conventional cigarettes and mostly used cross-sectional designs (Ambrose et al., 2014; Amrock et al., 2015; Chaffee et al., 2015). The limited research about perceived harm of e-cigarettes among youth indicated e-cigarettes were perceived as less harmful than conventional cigarettes (Ambrose et al., 2014; Amrock et al., 2015). Data regarding the relationship between perceived harm of e-cigarettes and e-cigarette use are scant (Ambrose et al., 2014). Furthermore, the long-term health consequences of e-cigarette use are unknown (Callahan-Lyon, 2014; Durmowicz, 2014).

Contribution the Study Makes to the Field

In the absence of consensus about the long-term health effects of e-cigarettes, youth's perceived harm of e-cigarettes have important implications for program development, public policies, and research to mitigate use of tobacco products in this population. The insight gleaned from the dissertation study can be used for program development to address perception or misperception related to e-cigarettes among youth. The dissertation study results may be used to inform public health policies, education, planning, and practice related to tobacco control. The dissertation study findings have expanded the literature about perceived harm of e-cigarettes and intentions to use e-cigarettes among youth.

Summary

Reducing tobacco-related death and diseases continues to be a national priority (CDC, 2016). An issue of major public health concern is youth use of e-cigarettes (Fairchild et al., 2014). There were over 460 e-cigarette brands on the market (Zhu et al., 2014). E-cigarettes varied in design, content, and ingredients, but most of these products contained nicotine, an addictive substance (Cobb et al., 2010; FDA, 2015). Some e-cigarettes also contained harmful or potentially harmful constituents (FDA, 2015). The long-term health effects of e-cigarette use are unknown, yet study findings indicated e-cigarette users perceived e-cigarettes as safer than conventional cigarettes (Adkison et al., 2013; Ambrose et al., 2014). In addition, almost one third of youth in the United States were susceptible to use of e-cigarettes (USDHHS, 2016). Some researchers found youth who have never smoked conventional cigarettes were using e-cigarettes (Corey et al.,

2013; Barrington-Trimis et al., 2015). These findings raised significant public health concerns, and interventions are needed to curtail e-cigarette use among youth.

The theory of reasoned action was used to guide this dissertation study. This theory is a useful framework for understanding the importance of specific beliefs, attitudes, norms, and intentions related to a behavior (Glanz et al., 1997). The aim of the theory is to understand and predict behavior. The dissertation study has captured aspects of the theory of reasoned action in the context of e-cigarettes in that the investigator examined relationships between perceived harm, susceptibility, and e-cigarette use. The investigator did not address subjective norms. The study contributed to the field of tobacco control by expanding the literature for perceived harm of e-cigarettes among youth.

Chapter 3: Methodology

Introduction to the Chapter

In this chapter, the research methods, including the specific procedures employed and data analyses, are described. The chapter includes an overview of the study sample and key variables. This investigator used quantitative research methods similar to those used in other studies pertaining to e-cigarette use. For example, Amrock et al. (2015) used data from the 2012 National Youth Tobacco survey to examine correlates of e-cigarette harm perception and use of e-cigarettes. The strength of the dissertation study includes the use of a large nationally representative sample to gain insight into youth's perceived harm of e-cigarettes.

Research Design and Methodology

Quantitative research uses numeric information and involves processes that are formal, systematic, and objective to describe and test relationships among variables (McCusker & Gunaydin, 2015). This quantitative study involved secondary analysis of de-identified data from the PATH study. This archival data was accessed from ICPSR (2017). The PATH study had a self-reported questionnaire to capture data from participants. The design was used for data to be captured from a large population in a consistent manner and reduced opportunity for bias from an interviewer. However, this design has less depth about a phenomenon and does not allow for probing. In the dissertation study, the investigator explored changes in perceived harm related to e-cigarettes and relationships between perceived harm of e-cigarettes and e-cigarette use among youth in the United States. The investigator also explored associations between

perceived harm of e-cigarettes and susceptibility to use of e-cigarettes. The investigator used correlational designs to address the research questions and hypotheses.

Secondary analysis involved the use of existing data to answer research questions or test new hypothesis and offers an economical and efficient means for conducting studies (Johnston, 2014). With the use of secondary data, the investigator was able to have access to de-identified data for the population and phenomena of interest to address the research questions. The PATH study has captured tobacco-related knowledge, attitudes, and behaviors from a nationally representative youth population (Hyland et al., 2017; ICPSR, 2017). Although the PATH study was not design for the dissertation study, use of data from Wave 1 and Wave 2 presented a feasible option for conducting the study.

Participants

This dissertation study was restricted to the 13,651 youth who participated in the PATH study. These participants lived in civilian, non-institutionalized settings in the United States (Hyland et al., 2017). The sample was selected based on age, awareness of e-cigarettes, and e-cigarette use. Individuals who were age 12 to 17 at Wave 1 of the PATH study were included in the study. Youth who did not respond to the PATH study question on awareness of e-cigarettes or who selected "No," "DON'T KNOW," or "REFUSED" in response to the PATH study question about awareness of e-cigarette at Wave 1 were excluded. In addition, youth who did not provide a response to the PATH study question on ever-use of e-cigarettes at Wave 1 were excluded from the study. Statistical Package for the Social Science (SPSS) version 24 was used to select the sample based on the study criteria.

Specific Procedures

Instruments and Measures

Population Assessment of Tobacco and Health Study. The PATH study is a longitudinal cohort study of 45,971 participants, including 13,651 youth. The study included individuals aged 12 years and older who resided in civilian, non-institutionalized settings in the 50 States and the District of Columbia. The study data was collected under a research contract with Westat and funded through a collaborative partnership between the National Institute of Health's NIDA and FDA's Center for Tobacco Products (Hyland et al., 2017; ICPSR, 2017).

The PATH study used a four-staged stratified probability sampling design to select baseline Wave 1 participants. The first stage of the sampling included selection of 156 primary sampling units. These sampling units consisted of counties or groups of contiguous counties. At the second stage, 6,049 sampling units were formed. At the third stage, 166,088 mailing addresses were sampled. At the fourth stage, 76,539 sampled persons within households occupying dwelling units at sampled addresses were selected. In general, up to two youths were sampled within a household. If more than two youths were in a household, two were selected at random for the sample (Hyland et al., 2017; ICPSR, 2017). At Wave 1, a total of 13,651 youth completed the interview with an overall youth response rate of 78.2% unweighted and 78.4% weighted. At Wave 2, a total of 10,081 youth continued in the PATH study and completed the interview with an overall retention rate of 88.5% unweighted and 88.4% weighted (ICPSR, 2017). An additional 5,855 youth were recruited at Wave 2 of which 2,091 completed the interview (ICPSR, 2017).

The baseline (Wave 1) data were collected from September 12, 2013, to December 14, 2014, and the Wave 2 data were collected from October 2014 to October 2015 (ICPSR, 2017). Both the Wave 1 and Wave 2 data were collected in person, using audio computer-assisted self-interviewing (ACASI) for the youth interviews. The youth interviews averaged around 35 minutes (ICPSR, 2017).

Variables. Secondary data from the PATH study were used to address the research questions and hypotheses discussed in Chapter 1. The full questionnaire utilized to capture the data for the PATH study is available on the ICPSR's Web site (ICPSR, 2017). In addition to demographics data, the investigator examined responses to relevant questions from the PATH study questionnaire that addressed the research questions and hypotheses.

Study eligibility. Responses to the following questions from the PATH study questionnaire were evaluated to determine eligibility for the study:

- May I please have {*Program: Insert Youth Name*}'s date of birth?
- Have you ever seen or heard of an electronic cigarette or e-cigarette before this study?
- Have you ever used an e-cigarette, such as NJOY, Blu, or Smoking Everywhere, even one or two times?

***Demographic variables*.** Four demographic variables were used to describe the sample: gender, age, race, and e-cigarette use status.

Perceived harm. To assess perceived harm relevant to the research questions and hypotheses, the dissertation study used the following two questions from the PATH study questionnaire:

- One question from the PATH study questionnaire was used to assess the perceived absolute harm of e-cigarettes. Youth were asked how much do you think people harm themselves when they use e-cigarettes? Response options were (a) *no harm*, (b) *little harm* (c) *some harm*, (d) *a lot of harm*, (e) *DON'T KNOW*, and (f) *REFUSED*.
- One question from the PATH study questionnaire was used to assess the perceived relative harm of e-cigarettes compared to conventional cigarettes. Youth were asked is using e-cigarettes less harmful, about the same, or more harmful than smoking cigarettes? Response options were (a) *less harmful*, (b) *about the same*, (c) *more harmful*, (d) *DON'T KNOW*, and (e) *REFUSED*.

***E-cigarette use*.** The following questions and user group variables from the PATH study questionnaire were used to assess e-cigarette use status:

- Have you ever used an e-cigarette, such as NJOY, Blu, or Smoking Everywhere, even one or two times? Response options were (a) *yes*, (b) *no*, (c) *DON'T KNOW*, and (d) *REFUSED*.
- Have you ever used an electronic nicotine product, even one or two times? (Electronic nicotine products include e-cigarettes, e-cigars, e-pipes, e-hookahs, personal vaporizers, vape pens, and hookah pens). Response options were (a) *yes*, (b) *no*, (c) *DON'T KNOW*, and (d) *REFUSED*.
- Which of the following electronic nicotine products have you ever used? Choose all that apply. Response options were *(a) e-cigarettes, (b) e-cigar, (c) e-pipe, (d) e-hookah (including hookah pen), (e) something else, (f) DON'T KNOW, and (g) REFUSED*.

- The following user group variables were used in assessing e-cigarette use status: Ever e-cigarette users, never e-cigarette users, initiated e-cigarette use since last completed interview.

Susceptibility to e-cigarette use. One question from the PATH study questionnaire was used to assess susceptibility to e-cigarette use. Youth were asked do you think that you will try an e-cigarette soon? Response options were (a) *definitely yes*, (b) *probably yes*, (c) *probably not*, (d) *definitely not*, (e) *DON'T KNOW*, and (f) *REFUSED*.

Smoking status. One question from the PATH study questionnaire was used to assess smoking status. Youth were asked have you ever tried cigarette smoking, even one or two puffs? Response options were (a) *yes*, (b) *no*, (c) *DON'T KNOW*, and (d) *REFUSED*.

Reliability and Validity

The most likely threat to external validity of the dissertation study was selection bias. The use of a stratified probability sampling design in the PATH study may have reduced this threat. Of the 17,451 youth contacted at Wave 1 to participate in the PATH study, 13,651 completed the interview (ICPSR, 2017). This dissertation study was limited to youth who participated in the PATH study; therefore, the study findings were limited to non-institutionalized youth in the United States.

The validity, reliability, or psychometric findings of the tool (questionnaire) used to collect the PATH study data were not available in the literature. However, the literature about the design and methods of the PATH study indicated that the Wave 1 questionnaire adapted items from several well-established national surveys and were

tailored to utilize the Audio Computer-Assisted Self-Interviewing (Hyland et al., 2017). The survey tool appeared to have face validity in that it seems to have measured the content. The PATH study was used and referenced in several research studies, including Kasza et al. (2017); Pearson et al. (2016); Persoskie, O'Brien, Nguyen, and Tworek (2017); Hyland et al. (2017); and Leas, Ayers, Strong, and Pierce (2016).

Ethical Considerations and Review

The dissertation study involved secondary analysis of de-identified data collected under the PATH study. Approval to conduct the PATH study was received from the Westat Institutional Review Board prior to data collection (Hyland et al., 2017). A Certificate of Confidentiality from the National Institutes of Health was obtained for conducting the PATH study. Consent was obtained from parents and assent was obtained from youth prior to data collection. In addition, approval to collect data under the PATH study was received from the Office of Management and Budget (Hyland et al., 2017).

Before conducting the dissertation study, exemption from Institutional Review Board review was obtained from Nova Southeastern Institutional Review Board. Only de-identified data were accessed and used in the study. This dissertation study did not involve any interactions with participants.

Funding

The dissertation study was unfunded. The study was conducted using the investigator's existing resources (i.e., a laptop computer, Internet access, and SPSS software) and public data. The dissertation study used secondary data available to the public at no cost. The investigator has Internet access and used a previously-owned laptop to download and analyze the data. Availability of these resources significantly

reduced any financial cost that would have otherwise been associated with conducting the study. Minimal cost was associated with procuring licensure to use SPSS software and tools to disseminate the study findings. However, the study did not require funding from any source.

Data Collection Procedures

The following steps were taken to obtain data for the current study:

- Step 1. Downloaded the secondary, de-identified dataset into SPSS from the archival PATH study data.
- Step 2. Used SPSS to extract data based on the study criteria.

Data Analyses

To characterize the study sample, descriptive statistics were used to generate frequencies of the participants' demographics included in the analyses. Inferential analyses were performed to address the research questions and hypotheses. Non-parametric statistical analyses were conducted when the level of measurements for the data were nominal. A two-tailed *p* less than .05 was considered statistically significant, unless otherwise specified.

Pairwise deletion was used to handle missing cases. Cases were deleted only if the variables being analyzed had missing data. To address Research Question 1, a paired-samples *t* test was used to assess whether perceived absolute harm of e-cigarettes and relative harm of e-cigarettes compared with conventional cigarettes changed between Wave 1 and Wave 2. To address Research Question 2, a paired-samples *t* test was used to assess whether perceived absolute harm of e-cigarettes coincided with changes in e-cigarette use status between Wave 1 and Wave 2. Logistic regression analyses were used

to address Hypothesis 1 and 2. To address Hypothesis 1, multivariate logistic regression analysis was used to assess whether perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and smoking status were associated with use of e-cigarettes at Wave 1. To address Hypothesis 2, multivariate logistic regression analysis was used to assess whether perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and smoking status were associated with subsequent use of e-cigarettes. To address Hypothesis 3, a chi-square test for independence was used to assess whether perceived harm of e-cigarettes was associated with susceptibility to use of e-cigarettes. To address Hypothesis 4, a chi-square test for independence was used to assess whether susceptibility to use of e-cigarettes at Wave 1 was associated with use of e-cigarettes at Wave 2.

Summary

The dissertation study used a correlational quantitative research design to (a) collect and analyze the data, (b) interpret the results, and (c) report the findings. Secondary analysis of de-identified data from the PATH study was conducted to answer the research questions and examine the hypotheses. The dissertation study was limited to youth who participated in the PATH study, which included individuals who lived in civilian, non-institutionalized settings in the United States (Hyland et al., 2017). Selection bias was the most likely threat to external validity. Exemption from review by an Institutional Review Board was obtained prior to conducting the dissertation study. The study was unfunded and the data were analyzed using SPSS version 24.

Chapter 4: Results

Introduction to the Chapter

The results of the analyses relevant to the research questions and hypotheses are presented in this chapter. The data were analyzed using the commercially available SPSS version 24. The data analyses were guided by the research questions and hypotheses discussed in Chapter 1. This chapter includes a summary of the study results.

Study Findings

Demographics

The study sample consisted of 12,154 youth participants from the PATH dataset. The sample characteristics at Wave 1 and Wave 2 are presented in Table 1. At Wave 1, the number of youth in the 12- to 14-year-old age group was proportionate to those in the 15- to 17-year-old age group (49.2% and 50.8%, respectively). In addition, male participants were proportionate to female participants (51.4% and 48.4%, respectively). The majority of participants were white (65.6%).

Table 1
Participants' Demographics

Descriptors	Wave 1 (%)	Wave 2 (%)
Age		
12 to 14	5,975 (49.2%)	5,624 (46.3%)
15 to 17	6,179 (50.8%)	5,213 (42.9%)
Missing	0 (0%)	1,317 (10.8%)
Gender		
Male	6,249 (51.4%)	5,537 (45.6%)
Female	5,878 (48.4)	5,274 (43.4%)
Missing	27 (0.2%)	1,343 (11%)
Race		
White Alone	7,979 (65.6%)	6,970 (57.3%)
Black Alone	1,771 (14.6%)	1,623 (13.4%)
Other	1,780 (14.6%)	1,612 (13.3%)
Missing	624 (5.1%)	1,949 (16%)

Of the 12,154 study participants, 1,451 (11.9%) reported ever use of an e-cigarette at Wave 1. Among youth who reported every use of e-cigarette at Wave 1, 75.7% were 15 to 17 years old, 57.8% were male, and 74% were White.

Research Question 1

How has the perceived absolute harm of e-cigarettes and relative harm of e-cigarettes compared with conventional cigarettes changed between Wave 1 and Wave 2 among a cohort of youth?

Valid responses about the perceived absolute harm of e-cigarettes at both Wave 1 and Wave 2 were provided by 9,964 youth. The respondents' demographic characteristics were similar to those of the overall sample with proportionate responses based on age group and sex. Youth in the 12- to 14-year-old age group accounted for 49.1% of the respondents, and those in the 15- to 17-year-old age group accounted for 50.9%. Males accounted for 51.3% of the respondents, and females accounted for 48.5%. The majority of respondents were White (65.6%). Of the 9,964 youth, 7,008 changed their responses about how much people harm themselves when they use e-cigarettes between Wave 1 and Wave 2. Table 2 displays the changes in perceived absolute harm between Wave 1 and Wave 2.

Table 2
Changes in Perceived Absolute Harm Between Wave 1 and Wave 2

Question	Response	Change between Wave 1 and Wave 2	
		Yes (%)	No (%)
How much people harm themselves when they use e-cigarettes	No harm	780 (11.1%)	44 (1.5%)
	A little harm	2,057 (29.4%)	568 (19.2%)
	Some harm	2,620 (37.4%)	1,545 (52.3%)
	A lot of harm	1,551 (22.1%)	799 (27%)
	Total	7,008	2,956

Table 3 displays the perceived absolute harm of e-cigarettes at Wave 1 and Wave 2. At both Wave 1 and Wave 2, most youth perceived some harm (41.8% and 37.8%, respectively) in terms of how much people harm themselves when they use e-cigarettes. The proportion of youth who perceived no harm, a little harm, or some harm in terms of how much people harm themselves when they use e-cigarette decreased from Wave 1 compared with Wave 2 (8.3% vs. 5.9%, 26.3% vs. 18.4%, and 41.8% vs. 37.8%, respectively). However, the proportion of youth who perceived "people harm themselves a lot when they use e-cigarettes" increased from Wave 1 compared with Wave 2 (23.6% and 34.5%, respectively). A paired-samples *t* test was conducted to evaluate the change in absolute perceived harm between Wave 1 and Wave 2 among youth. There was a statistically significant increase in absolute perceived harm from Wave 1 ($M = 2.81$, $SD = .890$) to Wave 2 ($M = 3.01$, $SD = .894$), $t(9963) = 15.895$, $p < .001$, $d = 0.2$. Cohen's *d* indicated a small effect size.

Table 3
Perceived Absolute Harm of E-cigarettes

Question	Response	Wave 1 (%)	Wave 2 (%)
How much people harm themselves when they use e-cigarettes	No harm	824 (8.3%)	588 (5.9%)
	A little harm	2,625 (26.3%)	2,175 (21.8%)
	Some harm	4,165 (41.8%)	3,764 (37.8%)
	A lot of harm	2,350 (23.6%)	3,437 (34.5%)
	Total	9,964	9,964

Valid responses about the perceived relative harm of e-cigarettes compared with conventional cigarettes at both Wave 1 and Wave 2 were provided by 8,857 youth. The respondents' demographic characteristics were similar to those of the overall sample with proportionate responses based on age group and sex. Youth in the 12- to 14-year-old age group accounted for 48.5% of the respondents and those in the 15- to 17-year-old age

group accounted for 51.5%. Males accounted for 51.3% of the respondents, and females accounted for 48.5%. The majority of respondents were White (65.7%). Of the 8,857 youth, 5,023 changed their responses about the level of harmfulness of e-cigarettes compared with smoking cigarettes between Wave 1 and Wave 2. Table 4 displays the changes in perceived relative harm of e-cigarettes compared to conventional cigarettes between Wave 1 and Wave.

Table 4
Changes in Perceived Relative Harm of E-Cigarettes Compared with Conventional Cigarettes

Question	Response	Change between Wave 1 and Wave 2	
		Yes (%)	No (%)
Level of harmfulness of e-cigarettes compared to smoking cigarettes	Less harmful	2,670 (53.2%)	2,101 (54.8%)
	About the same	1,944 (38.7%)	1,695 (44.2%)
	More harmful	409 (8.1%)	38 (1%)
	Total	5,023	3,834

Table 5 displays the perceived relative harm of e-cigarettes compared with conventional cigarettes at Wave 1 and Wave 2. At Wave 1, most youth perceived e-cigarettes to be less harmful compared with conventional cigarettes (53.9%). The proportion of youth who perceived e-cigarettes to be less harmful compared with conventional cigarettes decreased between Wave 1 and Wave 2 (53.9% and 44.3%, respectively). However, the proportion of youth who perceived the harmfulness of e-cigarettes to be about the same compared with conventional cigarettes increased between Wave 1 and Wave 2 (41.1% and 46.7%, respectively). Similarly, the proportion of youth who perceived e-cigarettes to be more harmful compared with conventional cigarettes increased between Wave 1 and Wave 2 (5% and 9%, respectively). A paired-samples *t* test was conducted to evaluate the change in perceived relative harm between Wave 1

and Wave 2 among youth. There was a statistically significant increase in perceived relative harm from Wave 1 (M = 1.51, SD = .592) to Wave 2 (M = 1.65, SD = .639), $t(8856) = 14.623$, $p < .001$, $d = 0.2$. Cohen's d indicated a small effect size.

Table 5
Perceived Relative Harm of E-Cigarettes Compared with Conventional Cigarettes

Question	Response	Wave 1 (%)	Wave 2 (%)
Level of harmfulness of e-cigarettes compared to smoking cigarettes	Less harmful	4,771 (53.9%)	3,920 (44.3%)
	About the same	3,639 (41.1%)	4,138 (46.7%)
	More harmful	447 (5%)	799 (9%)
	Total	8,857	8,857

Research Question 2

Do changes in the absolute perceived harm of e-cigarettes coincide with changes in e-cigarette use status between Wave 1 and Wave 2?

Valid responses about perceived absolute harm at both Wave 1 and Wave 2 were available from 706 new e-cigarette users and 7,813 non-new e-cigarette users at Wave 2. The respondents' demographic characteristics were similar to those of the overall sample with proportionate responses based on age group and sex. Youth in the 12- to 14-year-old age group accounted for 49.1% of the respondents, and those in the 15- to 17-year-old age group accounted for 50.9%. Males accounted for 51.2% of the respondents, and females accounted for 48.5%. The majority of respondents were White (65.4%). Table 6 displays the perceived absolute harm at Wave 1 and Wave 2 among new e-cigarette users. Among new e-cigarette users, the proportion who perceived no harm in terms of how much people harm themselves when they use e-cigarettes increased between Wave 1 and Wave 2 (8.5% and 16.1%, respectively). The proportion who perceived a little harm, in terms of how much people harm themselves when they use e-cigarettes also increased

between Wave 1 and Wave 2 (27.2% and 41.9%, respectively). However, the proportion who perceived some harm in terms of how much people harm themselves when they use e-cigarettes decreased between Wave 1 and Wave 2 (41.5% and 33%, respectively). Likewise, the proportion who perceived a lot of harm in terms of how much people harm themselves when they use e-cigarettes decreased between Wave 1 and Wave 2 (22.8% and 8.9%, respectively). A paired-samples *t* test was conducted to evaluate the change in perceived absolute harm between Wave 1 and Wave 2 among new e-cigarette users. There was a statistically significant decrease in perceived absolute harm from Wave 1 ($M = 2.79$, $SD = .892$) to Wave 2 ($M = 2.35$, $SD = .854$), $t(705) = 9.453$, $p < .001$, $d = 0.5$. Cohen's *d* indicated a medium effect size.

Table 6
Perceived Absolute Harm Among New E-Cigarette Users

Question	Response	Wave 1 (%)	Wave 2 (%)
How much people harm themselves when they use e-cigarettes	No harm	60 (8.5%)	114 (16.1%)
	A little harm	192 (27.2%)	296 (41.9%
	Some harm	293 (41.5%)	233 (33%)
	A lot of harm	161 (22.8%)	63 (8.9%)
	Total	706	706

Table 7 displays the perceived absolute harm at Wave 1 and Wave 2 among non-new e-cigarette users. Among the non-new e-cigarette users, the proportion who perceived no harm, a little harm, or some harm in terms of how much people harm themselves when they use e-cigarettes decreased between Wave 1 and Wave 2 (8.4% vs. 5.3%, 26.1% vs. 20.8%, 41.8 vs. 38.7%, respectively). However, the proportion who perceived people harm themselves a lot when they use e-cigarettes increased from Wave 1 (23.7%) compared with Wave 2 (35.2%). A paired-samples *t* test was conducted to evaluate the change in perceived absolute harm between Wave 1 and Wave 2 among non-

new e-cigarette users. There was a statistically significant increase in perceived absolute harm from Wave 1 (M = 2.81, SD = .893) to Wave 2 (M = 3.04, SD = .878), $t(7812)$ = 16.167, $p < .001$, d = 0.3. Cohen's d indicated a medium effect size.

Table 7
Perceived Absolute Harm Among Non-New E-Cigarette Users

Question	Response	Wave 1 (%)	Wave 2 (%)
How much people harm themselves when they use e-cigarettes	No harm	656 (8.4%)	414 (5.3%)
	A little harm	2,041 (26.1)	1,628 (20.8%)
	Some harm	3,262 (41.8%)	3,020 (38.7%)
	A lot of harm	1,854 (23.7%)	2,751 (35.2%)
	Total	7,813	7,813

Test of Hypothesis 1

Perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and smoking status are not associated with e-cigarette use at Wave 1. All predictors were entered into the model simultaneously.

A test of the full model against a constant-only model was statistically significant X^2 (5, N = 11164) = 2676.417, $p < .01$. In this model, the Hosmer-Lemeshow Test indicated support for the model, X^2 (7, N = 11164) = 7.363, p = .392. The Cox & Snell Square and the Nagelkerke R Square values indicated between 21.3% and 39.96% of the variability is explained by the model. Respondents who perceived e-cigarette to be less harmful than conventional cigarettes were more likely to have used e-cigarettes (OR = .372; 95% CI [.319, .433], $p < .01$). Similarly, the results showed those who perceived e-cigarettes as more harmful than conventional cigarettes were less likely than those who perceived e-cigarettes as less harmful than conventional cigarettes to report having used e-cigarettes (OR = .364; CI [.248, .532], $p < .05$). Those who were 15 to 17 years old were more likely than those 12 to 14 years old to report having used e-cigarette (OR =

2.050; 95% CI [1.767, 2.379], $p < .01$). Females were less likely than males to report having used e-cigarettes (*OR* = .747; 95% CI [.651, .856], $p < .01$). Those who had never tried smoking conventional cigarettes were less likely than those who had tried smoking conventional cigarettes to have used e-cigarettes (*OR* = .052, 95% CI [.045, .060], $p < .01$).

Test of Hypothesis 2

Among e-cigarette non-users at Wave 1, perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and smoking status are not associated with subsequent use of e-cigarettes at Wave 2. All predictors were entered into the model simultaneously.

A test of the full model against a constant-only model was not statistically significant X^2 (5, N = 1378) = 4.257, p = .513. In this model, the Hosmer-Lemeshow Test indicated support for the model, X^2 (8, N = 11164) = 6.251, p = .619. The Cox & Snell Square and the Nagelkerke R Square values indicated that less than 1% of the variability is explained by the model. The Wald criterion demonstrated perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and smoking status did not contribute significantly to the model.

Test of Hypothesis 3

Among e-cigarette non-users at Wave 1, perceived absolute harm of e-cigarettes is not associated with susceptibility to use of e-cigarettes.

Chi-square test for independence showed that there was a statistically significant relationship between perceived harm of e-cigarettes and susceptibility to use of e-cigarettes, X^2 (3, N = 10383) = 667.932, $p < .01$. Table 8 displays the association

between perceived absolute harm of e-cigarettes and susceptibility to use e-cigarettes. The proportion of youth who perceived a lot of harm in response to how much people harm themselves when they use e-cigarettes was higher among those who had a firm intention not to try e-cigarettes compared with those susceptible to use of e-cigarettes (30.3% and 9.5%, respectively).

Table 8
Perceived Absolute Harm of E-Cigarette Based on Susceptibility

Question	Response	Susceptible to use of e-cigarettes	
		Yes (%)	No (%)
How much people harm themselves when they use e-cigarettes	No harm	259 (12.1%)	415 (5%)
	A little harm	826 (38.5%)	1,646 (20%)
	Some harm	857 (39.9%)	3,682 (44.7%)
	A lot of harm	203 (9.5%)	2,495 (30.3%)
	Total	2,145	8,238

Test of Hypothesis 4

Susceptibility to use of e-cigarettes at Wave 1 is not associated with use of e-cigarettes at Wave 2.

Chi-square test for independence showed there was a statistically significant relationship between susceptibility to use of e-cigarettes at Wave 1 and e-cigarettes use status at Wave 2, X^2 (1, N = 7841) = 5.415, $p < .05$. Among new e-cigarettes users at Wave 2, 9.6% were susceptible to use of e-cigarettes, and 7.8% were not susceptible to use of e-cigarettes at Wave 1. Table 9 displays the association between susceptibility to use e-cigarettes at Wave 1 and new e-cigarettes use status at Wave 2.

Table 9
New E-Cigarette Use Status Based on Susceptibility

Question	Response	Susceptible to use of e-cigarettes	
		Yes (%)	No (%)
New e-cigarette user	Yes	155 (9.6%)	489 (7.8%)
	No	1,454 (90.4%)	5,743 (92.2%)
	Total	1,609	6,232

Summary of Results

Data analyses were conducted to answer the research questions and hypotheses outlined in Chapter 1. The demographic characteristics of the participants for the analysis were similar to those of the overall study sample. In terms of the research questions, the analyses showed perceived absolute harm of e-cigarettes and relative harm of e-cigarettes changed overtime, and changes in perceived absolute harm coincided with changes in e-cigarette use. Regarding the hypotheses, all but one of the null hypothesis was rejected in favor of the alternative. The analyses showed perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and smoking status were associated with e-cigarette use at Wave 1, but these factors were not associated with subsequent e-cigarette use at Wave 2. The analyses also showed perceived absolute harm of e-cigarettes was associated with susceptibility to use of e-cigarettes and susceptibility to use of e-cigarettes was associated with subsequent e-cigarette use.

Chapter 5: Discussion

Introduction to the Chapter

In this chapter, the interpretation, examination, and inferences of the study results are presented. The chapter includes discussion about the implications of the findings. The limitation and delimitations of the study are presented. This chapter includes recommendations and contains a summary of the entire paper.

Discussion and Interpretation of Results

Changes in Perceived Harm of E-Cigarettes

This is the first study to employ a large, nationally representative longitudinal survey data to examine perceived harm of e-cigarette and e-cigarette use among youth. Overall, most youth expressed that some harm is associated with e-cigarette use. Remarkably, perceived harm of e-cigarettes did not remain stagnant among youth, but changed overtime. General responses from youth concerning the perceived absolute and relative harm associated with e-cigarettes changed between Wave 1 and Wave 2. The findings indicated overtime, there was a statistically significant increase in the proportion of youth who perceived people harm themselves a lot when they use e-cigarettes. Furthermore, overtime, there was a decrease in the proportion of youth who perceived e-cigarettes to be less harmful compared with conventional cigarettes.

The baseline (Wave 1) data were collected from September 12, 2013, to December 14, 2014, and the Wave 2 data were collected from October 2014 to October 2015 (ICPSR, 2017). Due to the overlapping timeframe in which the PATH study data were collected, it was difficult to ascertain the underlying reasons for changes in

perceived harm or identify tobacco control developments that may have contributed to these changes.

Although characterization of the hazards and safety concerns with e-cigarettes in the literature may provide insight into the escalating concerns with e-cigarette harm, most of the reports were not published during the data collection interval and may not be relevant to the changes in perceived harm, but still warrant consideration. Published reports have identified numerous incidents of burn injuries and explosions related to e-cigarettes. Studies indicated certain conditions can cause e-cigarette batteries to overheat and or explode, which could lead to burn injuries (Brownson et al., 2016; Walsh et al. 2016). Corey et al. (2018) found 26 e-cigarette battery-related burn injuries led to emergency department visits in the United States and were captured in the Nationally Electronic Injury Surveillance System in 2016. Most of the injuries were thermal burns to the upper leg or lower trunk while the e-cigarette batteries were in the user's pocket. These findings were consistent with other reports of e-cigarette-related burn injuries (McKenna, 2017; Rudy & Durmowicz, 2016; Toy et al., 2017). One report noted a consumer complaint about an e-cigarette exploding in the consumer's mouth while driving that resulted in second-degree burns to the face (Chen, 2013). Durmowicz et al. (2016) also found that e-cigarette-related burn injuries were not confined to users, but also extended to non-users.

Similar to reports about burn injuries, published reports of associated e-cigarette adverse events did not coincide with the timeframe between Wave 1 and Wave 2 data collection period for the PATH study, but merit consideration in the context of information about e-cigarette harm. Published reports highlighted adverse events

associated with e-cigarette use, but a causal relationship between the adverse events and e-cigarette use could not be made. Serious adverse events related to e-cigarettes reported by complainants included possible infant death secondary to choking on e-cigarette cartridge, loss of vision requiring surgery, seizure, pneumonia, congestive heart failure, chest pain, and rapid heartbeat (Chen, 2013). In one study, researchers found frequent e-cigarette-associated adverse events included mouth or throat irritation, nausea, anxiety, insomnia, and depressed mood (Liu et al., 2018). In one study, researchers found that e-cigarette use may increase the risk of myocardial infraction (Alzahrani et al., 2018). In another study, researchers found prolonged exposure to some constituents of e-cigarette aerosols might be associated with respiratory complications, including chronic obstructive pulmonary disease, asthma, and inflammation (Kaur et al., 2018).

In addition to the plethora of reports of adverse events associated with e-cigarette use, the public health efforts to prevent youth initiation and use of e-cigarettes merits consideration in assessing possible contributors to changes in perceived harm of e-cigarettes. In 2016, in a surgeon general's report on e-cigarette use among youth and young adults, public health concerns were highlighted with these products. E-cigarettes may contain harmful constituents (USDHHS, 2016). Most e-cigarettes contain nicotine, an additive chemical that can cause harm to the developing adolescent brain (USDHHS, 2016). The Family Smoking Prevention and Tobacco Control Act requires the FDA to take a public health approach when developing regulations for tobacco products (FDA, 2018). This approach includes consideration for both users and non-users. Under the FDA 2016 deeming rule, e-cigarettes with nicotine are required to carry an addiction warning statement (FDA, 2018). In 2018, the FDA launched a campaign that included

focused messages about the dangers of nicotine in e-cigarettes to help discourage youth initiation and use of e-cigarettes (FDA, 2019). The CDC features a Web page, which contains resources to start a conversation about public health concerns with e-cigarettes and young people (CDC, 2018). The Web page includes quick facts about the risks of e-cigarettes to kids, teens, and young adults. The effects of these efforts by the FDA and CDC have not been reported in the literature. However, the steps taken by these national public health agencies underscore the concerns with e-cigarette use among youth in the United States.

Another notable finding from the dissertation study is that changes in perceived absolute harm of e-cigarettes coincided with changes in e-cigarette use between waves. Among new e-cigarette users, the proportion who perceived no harm or a little harm in terms of how much people harm themselves when they use e-cigarettes increased between Wave 1 and Wave 2 while the proportion who perceived some harm or a lot of harm decreased between Wave 1 and Wave 2. On the contrary, among youth who continued to be non-new e-cigarette users, the proportion who perceived no harm or a little harm in terms of how much people harm themselves when they use e-cigarettes decreased between Wave 1 and Wave 2 while the proportion who perceived some harm or a lot of harm increased between Wave 1 and Wave 2. The dissertation study design did not allow for inference as to whether the changes in perceived absolute harm of e-cigarettes occurred prior to, concurrently with, or proceeding e-cigarette use. Nevertheless, the findings indicated perceived harm may play a role in e-cigarette use status. The findings may also be reflective of the state of cognitive dissonance in this population.

These findings are consistent with the theory of reasoned action, which presents that perceived consequences of an action may predict behavioral intention and future behavior (Azjen & Fishbein, 1980). In two previous cross-sectional studies, researchers examined perceived harm and e-cigarette use among youth and found an association between perception of e-cigarettes as less harmful than conventional cigarettes and an increase in e-cigarette use (Ambrose et al., 2014; Amrock et al., 2015). Data from the 2016 National Youth Tobacco Survey (NYTS) showed self-reported reasons for e-cigarette use among middle and high school students who are e-cigarette users included the belief that "they are less harmful than other forms of tobacco such as cigarettes" (Tsai et al., 2018). Likewise, studies in the adult population also indicated an association between perception of e-cigarettes as less harmful than conventional cigarettes and an increase in e-cigarette use (Adkison et al., 2013; Choi & Foster, 2014; Goniewicz et al., 2013; Pepper & Brewer, 2014; Pearson et al., 2012; USDHHS, 2016). Results of the dissertation study was used to extend the previous cross-sectional study findings by not only indicating an association between perceived absolute harm and e-cigarette use but also presented insight into changes in perceived absolute harm of e-cigarettes among youth who progressed overtime from being never e-cigarette users to becoming an e-cigarette user.

Perceived Harm, Age, Gender, Smoking Status, and E-Cigarette Use

The investigator examined factors associated with e-cigarette use. One unique aspect of the dissertation study was the exploration of Wave 1 factors in terms of association with subsequent e-cigarette use at Wave 2. The hypothesis that perceived relative harm of e-cigarettes compared with conventional cigarette, age, gender, and

smoking status are not associated with e-cigarette use at Wave 1 was rejected in favor of the alternative, but these factors did not predict subsequent e-cigarette use at Wave 2. At Wave 1, the analysis indicated that each variable contributed significantly to the association with e-cigarette use. Youth who perceived e-cigarettes as more harmful than conventional cigarettes were less likely than those who perceived e-cigarettes as less harmful than conventional cigarettes to report that they have used e-cigarettes. Those who were 15 to 17 years old were more likely than those 12 to 14 years old to report having used e-cigarettes. Females were less likely than males to report having used e-cigarettes. Those who have never tried smoking conventional cigarettes were less likely than those who have tried smoking conventional cigarettes to have used e-cigarettes.

The Wave 1 findings are consistent with findings of previous cross-sectional studies examining e-cigarette use among youth. Both Ambrose et al. (2014) and Amrock et al. (2015) found youth who perceived e-cigarettes as less harmful relative to conventional cigarettes were more likely to have used e-cigarettes and having used other tobacco products were associated with increase in e-cigarette use. Amrock et al. (2015) also found that among adolescents, males were more likely than females to use e-cigarettes, and e-cigarette use increased with age. The findings that these factors did not predict subsequent e-cigarette use at Wave 2 elucidated the complexity in identifying pre-disposing factors associated with e-cigarette use.

Perceived Harm and Susceptibility to E-Cigarette Use

The hypothesis that among e-cigarette non-users at Wave 1, perceived absolute harm of e-cigarettes is not associated with susceptibility to use e-cigarettes was rejected in favor of the alternative. The findings indicated the majority of youth whether or not

susceptible to e-cigarette use perceived some harm from e-cigarette use. However, youth who were susceptible to e-cigarette use were less likely to perceive people harm themselves a lot when they use e-cigarettes. Among youth susceptible to use of e-cigarettes, 12.1% perceived no harm from e-cigarette use, and only 9.5% perceived a lot of harm from e-cigarette use. This finding is concerning given the mounting evidence of injuries and illnesses associated with e-cigarettes (Alzahrani et al., 2018; Liu et al., 2018; Rudy & Durmowicz, 2016; McKenna, 2017; Toy et al., 2017).

The findings that perceived absolute harm of e-cigarettes was associated with susceptibility to use e-cigarettes has extended findings from previous studies, which indicated susceptibility was associated with e-cigarettes use. As the theory of reasoned action presents, beliefs influence intentions and intentions influence behavior (Ajzen & Fishbein, 1980). In previous studies in the context of tobacco use, researchers indicated risk perception is a powerful predictor of progression to use (Song et al., 2009). Despite the lack of data about the long-term harm and adverse health effect of e-cigarettes, these products have increased in popularity and use (Carol Chapman & Wu, 2014). They are promoted in media accessible to youth (Banerjee et al., 2015). They were also promoted as a safer alternative to cigarettes (Zhu et al., 2014). These promotions may have belied growing evidence about the harms associated with e-cigarettes and the lack of long-term health effect data. Furthermore, the campaigns did not include information about the varying degrees of dangers associated with e-cigarette use, including the fact that e-cigarettes are not harmless. Nevertheless, these promotions may have shaped youth's beliefs and could lead to acceptability and eventual use of e-cigarettes.

One of the unique aspects of this dissertation study was the use of longitudinal data to assess the proportion of youth susceptible to e-cigarettes who progressed to actual use. The hypothesis that susceptibility to use of e-cigarettes at Wave 1 is not associated with use of e-cigarettes at Wave 2 was rejected in favor of the alternative. The findings indicated 9.6% of never-e-cigarette users susceptible to e-cigarette use at Wave 1 reported progression to actual use at Wave 2. Several explanations may support this finding. The theory of reasoned action presents that intention predicts behavior (Ajzen & Fishbein, 1980). This dissertation study showed susceptibility (i.e., the absence of a firm intention not to try an e-cigarette) was associated with a change in behavior (i.e., e-cigarette use). These findings have supported public health concerns about the increase use of e-cigarettes among youth. These findings also support the results of a previous study of middle and high school students in Connecticut, which found susceptibility was a predictor of future e-cigarette use (Bold et al., 2016).

Another interesting finding from the dissertation study was the proportion of youth not previously identified as susceptible to e-cigarette use who reported progression to actual use. This finding indicated that susceptibility alone may not be indicative of future use of e-cigarettes and underscored the need for multi-prong robust approaches to prevent e-cigarette use among youth. For example, further research to explore the reasons and drivers for youth use of e-cigarettes; targeted interventions for marketing, product design, and accessibility; and focused educational programs delivered via multiple platforms, such as social media, Internet, and classrooms. The need for continued surveillance and monitoring of e-cigarette use among youth were highlighted by the findings of the dissertation study.

The reasons for progression to e-cigarette use may be explained in part by the proliferation of e-cigarette advertising in media accessible to youth, including online, television, ratio, billboards, and advertising featuring celebrities (Banerjee et al., 2015; Richardson et al., 2014). In addition to availability, promotions via social media and Internet-based platforms may have played a crucial role in the increase use of e-cigarettes among youth. The availability of flavored e-cigarettes may have also contributed to appeal of these products to youth (Tsai et al., 2018). The totality of these marketing strategies could undermine public health efforts to mitigate e-cigarette use among youth. Researchers have reported the reasons youth used e-cigarettes include use by friend or family members, availability of flavors, and the belief that they were less harmful than other tobacco products (Tsai et al., 2018).

As the dissertation study has indicated, changes in perceived absolute harm of e-cigarettes coincided with e-cigarette use. Therefore, it is important to consider the role of perceived harm of e-cigarettes among youth who would not normally experiment with e-cigarettes. Promotion of e-cigarettes in media accessible to youth could inadvertently lead to youth initiation of these products. Initiation and use of e-cigarettes among youth is not benign, given the health-related harms associated with nicotine, including the negative effects on adolescent's brain development. Furthermore, substantial evidence exists regarding potential injuries and illnesses associated with e-cigarettes. In addition, concerns with e-cigarette use among youth included the potential for progression to smoking conventional cigarettes (Primack, et al., 2015; Wills et al., 2017).

Implications

Perceived harm of e-cigarettes may have influenced e-cigarette use among youth. This large, national, longitudinal dissertation study of youth presents a unique insight into the association between perceived harm and e-cigarette use. The findings from this dissertation study were vast and have broad implications for program developments, public policies, and future research that are aimed at reducing e-cigarette use among youth. The dissertation study findings may aide with integrating perceived harm into e-cigarette use prevention strategies and support the development of national policies and targeted programs to promote youth's health, safety, and quality of life.

Implications for Program Development

The findings from this dissertation study indicated perceived harm was associated with susceptibility to use e-cigarettes and susceptibility to use e-cigarettes was associated with subsequent e-cigarette use. These findings may contribute to the development of e-cigarette health-related messages tailored to youth and health care providers or other professionals who interact with youth, which may help shape youth's perception of e-cigarette harm. One of the most interesting findings from this dissertation study was that susceptibility alone may not be indicative of subsequent e-cigarette use. It may be necessary for programs to aim at mitigating youth use of e-cigarettes by incorporating diverse approaches that are not solely based on susceptibility factors, but also incorporate measures to address other factors contributing to e-cigarettes use. Targeted interventions may include educational strategies in multimedia platforms to address misconceptions about the harms of e-cigarettes. Interventions may also include community-driven programs to mitigate e-cigarette use among youth.

Implications for Public Policies

A major implication from this dissertation study was the need for perceived harm of e-cigarettes among youth to be included in tobacco control strategies. The findings indicated changes in perceived harm coincided with changes in e-cigarette use. Although the long-term health effects of e-cigarettes are debatable, information about potential injuries and illnesses are available. The findings presented an opportunity for policy makers to leverage information that is known about e-cigarettes in shaping how youth view the harmfulness of these products. These findings may be relevant for developing regulatory policies for the design, marketing, accessibility, or other factors that influence the perceived harm of e-cigarettes. Public policies may be needed to address the promotion of e-cigarettes in media or venues accessible to youth. Furthermore, public policies should address the lack of full disclosure of potential harms from use of e-cigarettes and the lack of restrictions on where e-cigarettes may be used. Policy makers may use the findings from this study to support development of public policies that are aimed at shaping youth's views of e-cigarettes and reducing e-cigarette use in this population.

Implications for Research

The dissertation study findings have expanded the knowledge base about e-cigarettes and added to the dearth of literature about perceived harm of e-cigarettes among youth. This longitudinal study indicated perceived harm of e-cigarettes changed overtime. This unique finding may serve as the baseline for future in-depth research to systematically assess the short-term and long-term perception of harm from e-cigarettes and further elucidate the complexity of the factors contributing to e-cigarette use. These

dissertation study findings have supported the need for future research to assess trends in perceived harm of e-cigarettes overtime, which may help guide interventions and policy developments. The dissertation study findings were used to highlight the complexity in determining the drivers for e-cigarette use among youth. Future research is needed to better understand the factors contributing to youth use of e-cigarettes. Qualitative research may be needed to dive deeper into the underlying factors shaping youth's perceived harm of e-cigarette, and longitudinal research may be needed to better understand how perceived harm changes and contributes to e-cigarette use.

Limitation and Delimitations

The study was confined to youth who participated in the PATH Study, which included individuals who lived in civilian, non-institutionalized settings in the United States (Hyland et al., 2017). The theory of reasoned action presents that attitudes and subjective norms influence intentions. This dissertation study did not address subjective norms.

This dissertation study has several limitations. The study findings are limited to non-institutionalized youth living in civilian sectors in the United States. The study design did not allow for causal inferences. The study used secondary data; therefore, the measures may not have been ideal for the dissertation study. The data analyzed in this study were based on self-reports; therefore, there is a potential for biased responses. For example, the PATH study participants may have intentionally or inadvertently misreported history of use of e-cigarettes. Exposures to e-cigarette advertising and socio-economical influences were not assessed in this dissertation study. These factors could be confounders in examining relationships between perceived harm and e-cigarette use.

Recommendations

Although the findings from this dissertation study presents unique insight into the relationship between perceived harm and e-cigarette use, further research is needed to support tobacco control strategies and reduce e-cigarette use among youth. Debates about the role of e-cigarette in the tobacco harm trajectory should be guided by a scientific foundation that addresses the effect of these products on youth. Examining perceived harm of discrete or distinguish e-cigarette product characteristics overtime may assist policy makers with developing regulatory guidelines for e-cigarette design features to curb uptake among youth. One area of interest would be determining whether perceived harm of e-cigarette changes as e-cigarette products evolve overtime or whether perceived harm varies based on e-cigarette product design. Likewise, evaluating perceived norm about e-cigarettes may be useful in understanding the underlying reasons youth use e-cigarettes. Such research may help to better understand the relationship between perceived harm, norms, and e-cigarette use.

In addition to research, targeted interventions may help address the increase in e-cigarette use. Several researchers reported about findings for programs that addressed illicit substance use among youth (Cuijpers, 2002; Das et al., 2016; Edalati & Conrod, 2019; NIDA, 2018b). However, the extent to which these programs may be applicable to e-cigarette use is unknown. Most of the substance use prevention programs were school based and included targeted interventions. For example, Das et al. (2016) found interventions for preventing drug abuse among youth included school-based interventions with combination approaches that focused on social competence and social influences. Edalati and Conrod (2019) found that targeting risk factors, such as anxiety, impulsivity,

sensation seeking, hopelessness, and sensitivity, in high-risk adolescent were effective in preventing drug use. NIDA recommends research-based prevention programs that enhance protective factors and reverse or reduce risk factors (NIDA, 2018b).

One issue with the varying degrees of substance use prevention program was the lack of standardized measures for interventions and outcomes (Das et al., 2016). In addition, the effectiveness of Internet-based programs is unknown. Although, approaches similar to those used for illicit substance use prevention may be considered for addressing e-cigarette use among youth, the programs should be tailored to e-cigarette use. The programs should include education about the harms associated with e-cigarette use, not merely based on the degree of harm associated with e-cigarettes compared with other abused substances. Despite the lack of evidence for Internet-based programs, consideration about the proliferation of information on Internet-based platforms, including social media, and accessibility to various flavors and e-cigarette designs may be important. Research may be useful to inform interventions for preventing e-cigarette use among youth and may help guide policies, school-based programs, mass media campaigns, and other targeted interventions.

Future qualitative and longitudinal studies are also needed to further understand how youth develop a perception of harm for e-cigarettes and perceived norms related to e-cigarette use. Findings from such research may be utilized to guide policy discussions and interventions that are aimed at discouraging youth from using e-cigarettes. Another area of interest would be exploring the circumstances under which youth uses e-cigarettes and investigating whether perceived harm coincides with circumstances of use. This information may assist with targeted interventions, including communication and

education strategies that are aimed at addressing misperception about the harm of e-cigarettes.

Tobacco control strategies should incorporate measures to ensure prevention of e-cigarette use among youth is at the forefront of any guidelines on e-cigarette design, marketing, and accessibility. The scale of these prevention efforts should align with the massive magnitude of the problem with escalating use of e-cigarettes among youth. The enormous efforts undertaking with anti-tobacco smoking campaigns may provide insight into the level of effort needed to combat the increase in e-cigarette use among youth. Longitudinal studies are needed to assess the aggregate effect of perceived harm, norms and e-cigarette use among youth at the population level. Policy makers should ensure actions are taken at all levels of society in order to inform youth about the dangers of e-cigarettes and mitigate use in this population.

Summary

E-cigarettes were intertwined in the evolution of tobacco product types and were central to debates about the tobacco harm trajectory, including effect of innovative products on population health. The emergent of e-cigarettes as an innovative tobacco product type have been compared with the paradigm shift in tobacco use ignited by conventional cigarettes in the early 20th century (USDHHS, 2016). The negative health effects of tobacco use are well documented. However, long-term effect of e-cigarettes on overall population health is unknown. Nevertheless, these products are of abundance in the United States and are the most prevalent tobacco product type used by youth (Cullen et al., 2018). Hence, mitigating e-cigarette use among youth is a major public health priority.

Although a plethora of studies have highlighted the negative health effects of tobacco use, the health consequences of e-cigarettes are not fully characterized. E-cigarettes were constantly evolving and varied in design and composition. Some e-cigarettes were designed to resemble other tobacco products, such as cigarettes, and others resembled common everyday items, such as pens or memory sticks (FDA, 2019). E-cigarettes were often promoted in media accessible to youth (Banerjee et al., 2015). In addition, they may be used in places where smoking was prohibited (Etter & Bullen, 2011; Grana et al., 2011). E-cigarettes were often promoted as a safer alternative to cigarettes and may be used in places where smoking is prohibited (Etter & Bullen, 2011; Grana et al., 2011). The diverse profile of e-cigarettes and the relatively short historical timeline of these products complicated assessments of the overall health effects, but the potential negative effect on youth have been a driving concern about these products.

Researchers found most e-cigarettes contained nicotine or other harmful constituents and may have adverse effect on youth's brain development (Cheng, 2014; FDA, 2014, Goniewicz, Knysak, et al., 2014; USDHHS, 2014, 2016). No tobacco product types, including e-cigarettes, have been found to have benign effect on youth. In the face of these concerns, e-cigarette advocates contended that these products may be used as a smoking cessation tool geared towards adults and thus served a role in reducing overall tobacco-related harm. However, researchers have provided mixed results about the usefulness of e-cigarettes as smoking cessation tools and a clear health benefit of e-cigarette is yet to emerge (Adkinson et al., 2013; Bullen et al., 2013; Caponnetto et al., 2013; Vikerman et al., 2013). These research studies were conducted prior to the

issuance of FDA's 2016 deeming rule, which extended FDA's regulatory authorities to other tobacco products, including e-cigarettes (FDA, 2018).

Concerns about e-cigarettes stems in part from the alarming proportion of youth who reportedly have used these products (Cullen et al., 2018). The concerns extended beyond use of e-cigarettes in it of itself to the products being used as a gateway to other tobacco products and could potentially renormalize tobacco use, including smoking (Fairchild et al., 2014; Rigotti, 2015). Despite these concerns, the reasons youth experiment with and use e-cigarettes are not fully understood, and little is known about perceived harm of e-cigarettes in association with e-cigarette use among this population.

Studies that have evaluated youth's perceived harm of e-cigarettes are scant. Several health research studies have been guided by the theory of reasoned action, which presents that beliefs about the positive and negative consequences of an action is a key predictor of behavioral intentions and future behavior (Azjen & Fishbein, 1980; Martinasek et al., 2017; Trumbo & Kim, 2015). With the dissertation study, framed within the theory of reasoned action, the investigator explored associations between perceived harm, susceptibility to use of e-cigarettes, and e-cigarette use.

The investigator utilized a subset of data from Wave 1 and Wave 2 of the PATH study to address the research questions and hypotheses. The PATH study used a stratified probability sampling design and captured data from non-institutionalized participants using self-reported questionnaires. The dissertation study was restricted to the youth who participated in the PATH study, and the sample was selected based on age, awareness of e-cigarettes, and e-cigarette use. Secondary analyses of the PATH study data were performed to address the research questions and hypotheses.

The data was analyzed using SPSS, and a two-tailed *p* less than .05 was considered statistically significant, unless otherwise noted. Data from 12,154 youth participants from the PATH study were analyzed. The demographic characteristics of the participants in terms of age group, gender, and race at Wave 1 were comparable with the characteristics at Wave 2. At Wave 1, the number of youth who were 12 to 14 years old was proportionate to those who were 15 to 17 years old. Likewise, the number of male participants was proportionate to female participants. Whites accounted for most of the participants.

Both perceived absolute harm of e-cigarettes and relative harm of e-cigarettes compared with conventional cigarettes increased from Wave 1 to Wave 2. However, among new e-cigarette users, perceived absolute harm of e-cigarettes decreased from Wave 1 to Wave 2 while among non-new e-cigarette users, perceived absolute harm of e-cigarettes increased from Wave 1 to Wave 2. At Wave 1, perceived relative harm of e-cigarettes compared with conventional cigarettes, age, gender, and smoking status were associated with e-cigarette use, but these factors were not associated with subsequent use of e-cigarettes at Wave 2. Perceived absolute harm of e-cigarettes was associated with susceptibility to use of e-cigarettes, and susceptibility to use of e-cigarettes at Wave 1 was associated with use of e-cigarettes at Wave 2.

The dissertation study findings indicated perceived harm of e-cigarettes changed overtime and coincided with changes in e-cigarette use among youth. The underlying reasons for these changes are unknown. The dissertation study findings also indicated perceived harm of e-cigarettes may be associated with susceptibility and use of e-

cigarettes. These findings are consistent with the theoretical framework of the theory of reasoned action, which presents that intention is in part a function of belief.

The dissertation study findings were used to expand the limited literature about perceived e-cigarette harm among youth and may help shape the debate surrounding e-cigarettes in the context of population health. The results may be used to inform tobacco control strategies, including program developments, policy decisions, and future research aimed at curtailing e-cigarette use among youth. Public policies will inevitably play a critical role in mitigating e-cigarette use among youth and efforts to guide policy developments are paramount to public health strategies aimed at reducing negative health consequences. Debates about the role of e-cigarettes in the tobacco harm trajectory must include assessment of the effect of perceived harm on youth initiation in concert with efforts to reduce tobacco-related injuries and death. Although this dissertation study was used to elucidate the association between perceived harm and e-cigarette use, additional research is needed to better understand the intricacies of these relationships.

The dissertation study has some limitations. The study design did not allow for conclusions to be drawn about causal connection. The use of self-reported data introduced the potential for biased responses, including misreported e-cigarette use status. Potential confounding factors of the relationship between perceived harm and e-cigarette use, including being exposed to e-cigarette advertisements or other socio-economical influences, were not assessed. Despite these limitations, the dissertation study findings have underscored the role of perceived harm in relationship to e-cigarette use among youth. Future studies are needed to further understand the underlying reasons youth use

e-cigarettes and to inform program and policy developments aimed at reducing youth use of e-cigarettes.

References

Adkison, S. E., O'Connor, R. J., Bansal-Travers, M., Hyland, A., Borland, R., Yong, H. H., . . . Fong, G. T. (2013). Electronic nicotine delivery systems: International tobacco control four-country survey. *American Journal of Preventative Medicine, 44*(3), 207-215. doi:10.1016/j.amepre.2012.10.018

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Upper Saddle River, NJ: Prentice-Hall, Inc.

Alzahrani, T., Pena, I., Temesgen, N., & Glantz, S. A. (2018). Association between electronic cigarette use and myocardial infarction. *American Journal of Preventative Medicine, 44*(4), 455-461. doi:https://doi.org/10.1016/j.amepre.2018.05.004

Ambrose, B. K., Rostron, B. L., Johnson, S. E., Portnoy, D. B., Apelberg, B. J., Kaufman, A. R., & Choiniere, C. J. (2014). Perceptions of the relative harm of cigarettes and e-cigarettes among U.S. youth. *American Journal of Preventative Medicine, 47*(2 Suppl. 1), S53-S60. doi:10.1016/j.amepre.2014.04.016

Amrock, S. M., Zakhar, J., Zhou, S., & Weitzman, M. (2015). Perception of e-cigarette harm and its correlation with use among U.S. adolescents. *Nicotine & Tobacco Research, 17*(3), 330-336. doi:10.1093/ntr/ntu156

Arrazola, R. A., Singh, T., Corey, C. G., Husten, C. G., Neff, L. J., Apelberg, B. J., . . . Caraballo, R. S. (2015, April 17). Tobacco use among middle and high school students—United States, 2011-2014. *Morbidity and Mortality Weekly Report, 64*(14), 381-385.

Aryal, U. R., & Bhatta, D. N. (2015). Perceived benefits and health risks of cigarette smoking among young adults: Insights from a cross-sectional study. *Tobacco Induced Diseases, 13*(1), 22. doi:10.1186/s12971-015-0044-9

Banerjee, S., Shuk, E., Greene, K., & Ostroff, J. (2015). Content analysis of trends in print magazine tobacco advertisements. *Tobacco Regulatory Science 1*(2), 103–120.

Barrington-Trimis, J. L., Berhane, K., Unger, J. B., Cruz, T. B., Huh, J., Leventhal, A. M., . . . McConnell, R. (2015). Psychosocial factors associated with adolescent electronic cigarette and cigarette use. *Pediatrics, 136*(2), 308-317. doi:10.1542/peds.2015-0639

Barrington-Trimis, J. L., Urman, R., Berhane, K., Unger, J. B., Cruz, T. B., Pentz, M. A. . . . McConnell, R. (2016). E-cigarettes and future cigarette use. *Pediatrics, 138*(1), 1-8. doi:10.1542/peds.2016-0379

Biener, L., & Hargraves, J. L. (2015). A longitudinal study of electronic cigarette use among a population-based sample of adult smokers: Association with smoking cessation and motivation to quit. *Nicotine Tobacco & Research, 17*(2), 127-133. doi:10.1093/ntr/ntu200

Biener, L., Song, E., Sutfin, E. L., Sangler, J., & Wolfson, M. (2015). Electronic cigarette trial and use among young adults: Reasons for trial and cessation of vaping. *International Journal of Environmental Research and Public Health 12*(2), 16019-16026.

Bold, K. W., Kong, G., Cavallo, D. A., Camega, D. R., & Krishnan-Sarin, S. (2016). E-cigartte susceptibility as a predictor of youth initation of e-cigarettes. *Nicotine Tobacco Research, 20*(1), 140-144. doi:10.1093/ntr/ntw393

Brownson, E. G., Thompson, C. M., Goldsberry, S., Chong, H. J, Friedrich, J. B, Pham, T. N., . . . Gibran, N. S. (2016). Explosion injuries from e-cigarettes. *New England Journal of Medicine, 375*(14), 1400-1402.

Bullen, C., Howe, C., Laugesen, M., McRobbie, H., Parag, V., Williman, J., & Walker, N. (2013). Electronic cigarettes for smoking cessation: A randomised controlled trial. *Lancet, 382*(9905), 1629-1637. doi:10.1016/S0140-6736(13)61842-5

Bunnell, R. E., Agaku, I. T., Arrazola, R. A., Apelberg, B. J., Caraballo, R. S., Corey, C. G., . . . King, B. A. (2015). Intentions to smoke cigarettes among never-smoking US middle and high school electronic cigarette users: National youth tobacco survey, 2011-2013. *Nicotine & Tobacco Research, 17*(2), 228-235. doi:10.1093/ntr/ntu166

Callahan-Lyon, P. (2014). Electronic cigarettes: Human health effects. *Tobacco Control, 23*(Suppl. 2), ii36-ii40. doi:10.1136/tobaccocontrol-2013-051470

Camenga, D. R., Delmerico, J., Kong, G., Cavallo, D., Hyland, A., Cummings, K. M., & Krishnan-Sarin, S. (2014). Trends in use of electronic nicotine delivery systems by adolescents. *Addictive Behaviors, 39*(1), 338-340. doi:10.1016/j.addbeh.2013.09.014

Caponnetto, P., Campagna, D., Cibella, F., Morjaria, J. B., Caruso, M., Russo, C., & Polosa, R. (2013). EffiCiency and Safety of an eLectronic cigAreTte (ECLAT) as

tobacco cigarettes substitute: A prospective 12-month randomized control design study. *PLoS One, 8*(6), 1-12. doi:10.1371/journal.pone.0066317

Carroll Chapman, S. L., & Wu, L. T. (2014). E-cigarette prevalence and correlates of use among adolescents versus adults: A review and comparison. *Journal of Psychiatric Research, 54*, 43-54. doi:10.1016/j.jpsychires.2014.03.005

Centers for Disease Control and Prevention. (2014). National adult tobacco survery questionnarire, 2012-2013. Retrieved from http://www.cdc.gov/tobacco/data_statistics/surveys/nats/pdfs/2012-2013-questionnaire.pdf

Centers for Disease Control and Prevention. (2016a). E-cigarette ads and youth. Retrieved from http://www.cdc.gov/vitalsigns/ecigarette-ads/index.html

Centers for Disease Control and Prevention. (2016b). Smoking & tobacco use: Fast facts. Retrieved from https://www.cdc.gov/tobacco/data_statistics/fact_sheets/fast_facts/

Centers for Disease Control and Prevention. (2018). Smoking & tobacco use. Retrieved from https://www.cdc.gov/tobacco/basic_information/e-cigarettes/Quick-Facts-on-the-Risks-of-E-cigarettes-for-Kids-Teens-and-Young-Adults.html

Chaffee, B. W., Gansky, S. A., Halpern-Felsher, B., Couch, E. T., Essex, G., & Walsh, M. M. (2015). Conditional risk assessment of adolescents' electronic cigarette perceptions. *American Journal of Health Behavior, 39*(3), 421-432. doi:10.5993/AJHB.39.3.14

Chen, I. (2013). FDA summary of adverse events on eletronic cigarettes. *Nicotine & Tobacco Research, 15*(2), 615-616. doi:10.1093/ntr/nts145

Cheng, T. (2014). Chemical evaluation of electronic cigarettes. *Tobacco Control, 23*(Suppl. 2), ii11-ii17. doi: 10.1136/tobaccocontrol-2013-051482

Choi, K., Fabian, L., Mottey, N., Corbett, A., & Forster, J. (2012). Young adults' favorable perceptions of snus, dissolvable tobacco products, and electronic cigarettes: Findings from a focus group study. *American Journal of Public Health, 102*(11), 2088-2093. doi:10.2105/AJPH.2011.300525

Choi, K., & Forster, J. (2013). Characteristics associated with awareness, perceptions, and use of electronic nicotine delivery systems among young US Midwestern adults. *American Journal of Public Health, 103*(3), 556-561. doi:10.2105/AJPH.2012.300947

Choi, K., & Forster, J. L. (2014). Beliefs and experimentation with electronic cigarettes: A prospective analysis among young adults. *American Journal of Preventative Medicine, 46*(2), 175-178. doi:10.1016/j.amepre.2013.10.007

Cobb, N. K., Byron, M. J., Abrams, D. B., & Shields, P. G. (2010). Novel nicotine delivery systems and public health: The rise of the "e-cigarette." *American Journal of Public Health, 100*(12), 2340-2342. doi:10.2105/AJPH.2010.199281

Cooke, R., & French, D. P. (2008). How well do the theory of reasoned action and theory of planned behaviour predict intentions and attendance at screening programmes? A meta-analysis. *Psychology & Health, 23*(7), 745–765. doi.org/10.1080/08870440701544437.

Corey, C. G, Chang, J. T., & Rostron, B. L. (2018). Electronic nicotine delivery system (ENDS) battery-related burns presenting to US emergency departments, 2016. *Injury Epidemiology, 5*(1), 4. doi:10.1186/s40621-018-0135-1

Corey, C., Wang, B., Johnson, S. E., Apelberg, B., Husten, C., King, B. A., . . . Dube S. R. (2013, September 6). Notes from the field: Electronic cigarette use among middle and high school students: United States, 2011-2012. *Morbidity and Mortality Weekly Report, 62*(35), 729-730.

Cuijpers, P. (2002). Effective ingredients of school-based drug prevention programs a systematic review. *Addictive Behaviors, 27*(6), 1009-1023.

Cullen, K. A., Ambrose, B. K,, Gentzke, A. S., Apelberg, B. J., Jamal, A., & King, B. A. (2018, November 16). Notes from the field: Increase in use of electronic cigarettes and any tobacco product among middle and high school students—United States, 2011–2018. *Morbidity and Mortal Weekly Report, 67*(45), 1276–1277.

Das, J. K., Salam, R. A., Arshad, A., Finkelstein, Y., & Bhutta, Z. A. (2016). Interventions for adolescent substance abuse: An overview of systematic reviews. *Journal of Adolescent Health, 59*(Suppl. 4), S61-S75. doi:10.1016/j.jadohealth.2016.06.021

Durmowicz, E. L. (2014). The impact of electronic cigarettes on the pediatric population. *Tobacco Control, 23*(Suppl. 2, ii41-ii46. doi: 10.1136/tobaccocontrol-2013-051468

Durmowicz, E. L., Rudy, S. F., & Chen, I. L. (2016). Electronic cigarettes: Analysis of FDA adverse experience reports in non-users. *Tobacco Control, 25*(2), 242. doi:10.1136/tobaccocontrol-2015-052235

Edalati, H., & Conrod, P. J. (2019). A review of personality-targeted interventions for prevention of substance misuse and related harm in community samples of adolescents. *Frontiers in Psychiatry, 9,* 770. doi:10.3389/fpsyt.2018.00770.

Etter, J. F., & Bullen, C. (2011). Electronic cigarette: users profile, utilization, satisfaction and perceived efficacy. *Addiction, 106*(11), 2017-2028. doi:10.1111/j.1360-0443.2011.03505.x

Fairchild, A. L., Bayer, R., & Colgrove, J. (2014). The renormalization of smoking? E-cigarettes and the tobacco "endgame." *New England Journal of Medicine, 370*(4), 293-295. doi:10.1056/NEJMp1313940

Food and Drug Adminstration. (2014). Summary of results: Laboratory analysis of electronic cigarettes conducted by FDA. Retrieved from http://www.fda.gov/NewsEvents/PublicHealthFocus/ucm173146.htm.

Food and Drug Adminstration. (2015). Electronic cigarettes (e-cigarettes). Retrieved from http://www.fda.gov/NewsEvents/PublicHealthFocus/ucm172906.htm

Food and Drug Adminstration. (2018). Tobacco produts: Rules and regulations. Retrieved from https://www.fda.gov/TobaccoProducts/Labeling/RulesRegulationsGuidance/ucm283974.htm

Food and Drug Adminstration. (2019). Tobacco produts: CTP newsroom. Retrieved from https://www.fda.gov/TobaccoProducts/NewsEvents/default.htm

Gilbert, H. A. (1963). Smokeless non-tobacco cigarette. Retrieved from http://www.google.de/patents/US3200819

Gimenez-Garcia, C., Ballester-Arnal, R., Gil-Llario, M. D., Cardenas-Lopez, G., & Duran-Baca, X. (2013). Culture as an influence on the perceived risk of HIV infection: A differential analysis comparing young people from Mexico and Spain. *Journal of Community Health, 38*(3), 434-442. doi:10.1007/s10900-012-9636-y

Glanz, K., Lewis, F. M., & Rimer, B. K. (Eds.). (1997). *Health behavior and health education: Theory, research, and practice* (2nd ed.). San Francisco, CA: Jossey-Bass, Inc.

Goniewicz, M. L., Kuma, T., Gawron, M., Knysak, J., & Kosmider, L. (2013). Nicotine levels in electronic cigarettes. *Nicotine & Tobacco Research, 15*(1), 158-166. doi:10.1093/ntr/nts103

Goniewicz, M. L., Hajek, P., & McRobbie, H. (2014). Nicotine content of electronic cigarettes, its release in vapour and its consistency across batches: Regulatory implications. *Addiction, 109*(3), 500-507. doi:10.1111/add.12410

Goniewicz, M. L., Knysak, J., Gawron, M., Kosmider, L., Sobczak, A., Kurek, J., . . . Benowitz, N. (2014). Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tobacco Control, 23*(2), 133-139. doi:10.1136/tobaccocontrol-2012-050859

Goniewicz, M. L., Gupta, R., Lee, Y. H., Reinhardt, S., Kim, S., Kim, B., . . . Sobczak, A. (2015). Nicotine levels in electronic cigarette refill solutions: A comparative analysis of products from the U.S., Korea, and Poland. *International Journal of Drug Policy, 26*(6), 583-588. doi:10.1016/j.drugpo.2015.01.020

Grana, R. A., Glantz, S. A., & Ling, P. M. (2011). Electronic nicotine delivery systems in the hands of Hollywood. *Tobacco Control, 20*(6), 425-426. doi:10.1136/tc.2011.043778

Hyland, A., Ambrose, B., Conway, K. P., Borek, N., Lambert, E., Carusi, C., . . . Compton, W. M. (2017). Design and methods of the population assessment of tobacco and health (PATH) study. *Tobacco Control, 26*(4), 371-378. doi:10.1136/tobaccocontrol-2016-052934

Inter-university Consortium for Political and Social Research. (2017). National addiction & HIV data archive program: Population assessment of tobacco and health (PATH) study [United States] restricted-use files (ICPSR 36231). Retrieved from http://www.icpsr.umich.edu/icpsrweb/NAHDAP/studies/36231

Johnston, L. D., Miech, R. A., O'Malley, P. M., Bachman, J. G., Schulenberg, J. E., & Patrick, M. E. (2019). *Monitoring the future national survey results on drug use 1975-2018: Overview, key findings on adolescent drug use.* Ann Arbor, MI: Institute for Social Research, University of Michigan. Retrieved from http://www.monitoringthefuture.org//pubs/monographs/mtf-overview2018.pdf

Johnston, M. P. (2014). Secondary data analysis: A method of which the time has come. *Qualitative and Quantitative Methods in Libraries, 3*(3), 619-626. Retrieved from http://www.qqml-journal.net/index.php/qqml/article/view/169/170

Kasza, K. A., Ambrose, B., K., Conway, K. P., Borek, N., Taylor, K., Goniewicz, M., L., . . . Hyland, A. J. (2017). Tobacco-product use by adults and youths in the United States in 2013 and 2014. *New England Journal of Medicine, 376*, 342-353.

Kaur, G., Pinkston, R., Mclemore, B., Dorsey, W., & Batra, S. (2018). Immunological and toxicological risk assessment of e-cigarettes. *European Respiratory Review, 27*(147), 1-14. doi:10.1183/16000617.0119-2017

Leas, E. C., Ayers, J. W., Strong, D. R., & Pierce, J. P. (2016). Which cigarettes do Americans think are safer? A polulation-based analysis with wave 1 of the PATH study. *Tobacco Control,26,* e59-e60. Retrieved from http://dx.doi.org/10.1136/tobaccocontrol-2016-053334

Leventhal, A. M., Strong, D. R., Kirkpatrick, M. G., Unger, J. B., Sussman, S., Riggs, N. R., . . . Audrain-McGovern, J. (2015). Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *Journal of the American Medical Association, 314*(7), 700-707. doi:10.1001/jama.2015.8950

Lik, H. (2007). Electronic attomization cigarette. Retrieved from http://worldwide.espacenet.com/publicationDetails/biblio?CC=US&NR=2007267031&KC=&FT=E&locale=en_EP

Li, J., Newcombe, R., & Walton, D. (2015). The prevalence, correlates and reasons for using electronic cigarettes among New Zealand adults. *Addictive Behaviors, 45,* 245-251. doi:10.1016/j.addbeh.2015.02.006

Liu, X., Lu, W., Liao, S., Deng, Z., Zhang, Z., Liu, Y., & Lu, W. (2018). Efficiency and adverse events of electronic cigarettes a systematic review and meta-analysis (PRISMA-compliant article). *Medicine (Baltimore), 97*(19), 1-8. doi:10.1097/MD.0000000000010324

Martinasek, M. P., Haddad, L. G., Wheldon, C. W., & Barnett, T. E. (2017). Beliefs and attitudes associated with hookah smoking among a United States college population. *Respiratory Care, 62*(3), 370-379. doi:10.4187/respcare.05069

McCusker, K., & Gunaydin, S. (2015). Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion, 30*(7), 537–542. doi:10.1177/0267659114559116

McKenna, L. A. (2017). Electronic cigarette fires and explosions in the United States 2009-2016. Retrieved from https://www.usfa.fema.gov/downloads/pdf/publications/electronic_cigarettes.pdf

Murphy-Hoefer, R., Alder, S., & Higbee, C. (2004). Perceptions about cigarette smoking and risks among college students. *Nicotine & Tobacco Research, 6*(Suppl. 3), S371-374.

Nadora, J., Hartman, S. J., Strong, D. R., Messer, K., Vera, L. E., White, M. M., . . . Pierce, J. P. (2014). Curiosity predicts smoking experimentation independent of susceptibility in a US national sample. *Addictive Behaviors, 39*(12), 1695-1700.

National Institute on Drug Abuse. (2014). Monitoring the future 2014 survey results. Retrieved from http://www.drugabuse.gov/related-topics/trends-statistics/infographics/monitoring-future-2014-survey-results

National Institute on Drug Abuse. (2018a). Advancing addiction science: Electronic cigarettes (e-cigarettes) retrieved from https://www.drugabuse.gov/publications/drugfacts/electronic-cigarettes-e-cigarettes

National Institute on Drug Abuse. (2018b). Drugs, brains, and behavior: The science of addiction. Retrieved from https://d14rmgtrwzf5a.cloudfront.net/sites/default/files/soa.pdf

Neff, L. J., Arrazola, R. A., Caraballo, R. S., Corey, C. G., Cox, S., King, B. A., . . . Husten, C. G. (2015, October 17). Frequency of tobacco use among middle and high school students—United States, 2014. *Morbidity and Mortality Weekly Report, 64*(38), 1061-1065. doi:10.15585/mmwr.mm6438a1

Noonan, D., & Kulbok, P. A. (2012). Beliefs and norms associated with smoking tobacco using a waterpipe among college students. *Journal of Addiction Nursing, 23*(2), 123-128. doi:10.3109/10884602.2012.669420

Pauly, J., Li, Q., & Barry, M. B. (2007). Tobacco-free electronic cigarettes and cigars deliver nicotine and generate concern. *Tobacco Control, 16*(5), 357. doi:10.1136/tc.2006.019687

Pearson, J. L., Johnson, A., Villanti, A., Glasser, A. M., Collins, L., Cohn, A., . . . Stanton, C. A. (2016). Misperceptions of harm among Natural American Spirirt smokers: Results from wave 1 of the population assessment of tobacco and health (PATH study (2013-2014). *Tobacco Control,* 1-7. doi:10.1136/tobaccocontrol-2016-053265

Pearson, J. L., Richardson, A., Niaura, R. S., Vallone, D. M., & Abrams, D. B. (2012). E-cigarette awareness, use, and harm perceptions in US adults. *American Journal of Public Health, 102*(9), 1758-1766.

Pepper, J. K., & Brewer, N. T. (2014). Electronic nicotine delivery system (electronic cigarette) awareness, use, reactions and beliefs: A systematic review. *Tobacco Control, 23*(5), 375-384. doi:10.1136/tobaccocontrol-2013-051122

Persoskie, A., O'Brien, E. K., Nguyen, A. B., & Tworek, C. (2017). Measuring youth beliefs about the harms of e-cigarettes and smokeless tobacco compared to cigarettes. *Addictive Behaviors, 70,* 7-13.

Pierce, J. P., Choi, W. S., Gilpin, E. A., Farkas, A. J., & Merrit, R. K. (1996). Validation of susceptibility as a predictor of which adolsecents take up smoking in the United States. *Health Psychology, 15*(5), 355-361.

Pierce, J. P., Distefan, J. M., Kaplan, R. M., & Gilpin, E. A. (2005). The role of curiosity in smoking initiation. *Addictive Behaviors, 30*(4), 685-696.

Polosa, R., Caponnetto, P., Morjaria, J. B., Papale, G., Campagna, D., & Russo, C. (2011). Effect of an electronic nicotine delivery device (e-cigarette) on smoking reduction and cessation: A prospective 6-month pilot study. *BMC Public Health, 11*, 786. doi:10.1186/1471-2458-11-786

Primack, B. A., Soneji, S., Stoolmiller, M., Fine, M. J., & Sargent, J. D. (2015). Progression to traditional cigarette smoking after electronic cigarette use among U.S. adolescents and young adults. *Journal of the American Medical Association Pediatrics, 169*(11) 1018-1023.

Richardson, A., Ganz, O., Stalgaitis, C., Abrams, D., & Vallone, D. (2014). Noncombustible tobacco product advertising: How companies are selling the new face of tobacco. *Nicotine & Tobacco Research, 16*(5), 606–614.

Rigotti, N. A. (2015). E-cigarette use and subsequent tobacco use by adolescents: New evidence about a potential risk of e-cigarettes. *Journal of the American Medical Association, 314*(7), 673-674. doi:10.1001/jama.2015.8382

Rostron, B. L., Chang, C. M., & Pechacek, T. F. (2014). Estimation of cigarette smoking—Attributable morbidity in the United States. *Journal of the American Medical Association Internal Medicine, 174*(12), 1992-1928. doi:10.1001/jamainternmed.2014.5219

Rudy, S. F., & Durmowicz, E. L. (2016). Electronic nicotine delivery systems: Overheating, fires and explosions. *Tobacco Control, 26* (1), 1-25. doi:10.1136/tobaccocontrol-2015-052626

Sheppard, B. H., Hartwick, J., & Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of Consumer Research, 15,* 325-343.

Song, A. V., Morrell, H. E., Cornell, J. L., Ramos, M. E., Biehl, M., Kropp, R. Y., & Halpern-Felsher, B. L. (2009). Perceptions of smoking-related risks and benefits as predictors of adolescent smoking initiation. *American Journal of Public Health, 99*(3), 487–492.

Toy, J., Dong, F., Lee, C., Zappa, D., Le, T., Archambeau, B., Culhane, J. T., & Neeki, M. M. (2017). Alarming increase in electronic nicotine delivery systems-related burn injuries: A serious unregulated public health issue. *American Journal of Emergency Medicine, 35*(11), 1781-1782. doi:10.1016/j.ajem.2017.05.029

Trumbo, C. W., & Kim, S. J. (2015). The effect of electronic cigarette advertising on intended use among college students. *Addictive Behaviors, 46,* 77-81.

Tsai, J., Walton, K., Coleman, B. N., Sharpova, S. R., Johnson, S. E., Kennedy, S. M., & Carabllo, R. S. (2018, February 16). Reasons for electronic cigarette use among middle and high school students—National youth tobacco survey, United States, 2016. *Morbidity and Mortality Weekly Report, 67*(6), 196-200. doi:10.15585/mmwr.mm6706a5

U.S. Department of Health and Human Services. (2000). *Reducing tobacco use: A report of the surgeon general*. Atlanta, GA: Author Retrieved from https://www.cdc.gov/tobacco/data_statistics/sgr/2000/complete_report/pdfs/fullreport.pdf

U.S. Department of Health and Human Services. (2012). *Preventing tobacco use among youth and young adults.* Atlanta, GA: Author. Retrieved from http://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use/full-report.pdf

U.S. Department of Health and Human Services. (2014). *The health consequences of smoking—50 years of progress: A report of the surgeon general.* Rockville, MD: Office on Smoking and Health. Retrieved from http://www.surgeongeneral.gov/library/reports/50-years-of-progress/full-report.pdf

U.S. Department of Health and Human Services. (2016). *E-cigarette use among youth and young adults: A report of the surgeon general.* Atlanta, GA: Author. Retrieved from https://www.cdc.gov/tobacco/data_statistics/sgr/e-cigarettes/pdfs/2016_sgr_entire_report_508.pdf

U.S. Preventative Task Services Task Force. (2015). Behaviorial and pharmacotherapy interventions for tobacco smoking cessation in adults, including pregnat wormen: U.S. Preventative Services Task Force recommendation statement. *Annals of Internal Medicine, 163*(8), 622-635.

Vickerman, K. A., Carpenter, K. M., Altman, T., Nash, C. M., & Zbikowski, S. M. (2013). Use of electronic cigarettes among state tobacco cessation quitline callers. *Nicotine Tobacco & Research, 15*(10), 1787-1791. doi:10.1093/ntr/ntt061

Walsh, K., Sheikh, Z., Johal, K., & Khwaja, N. (2016). Rare case of accidental fire and burns caused by e-cigarette batteries. *BMJ Case Report*, 1-3. doi:10.1136/bcr-2015-212868

Weiss, R. B., Baker, T. B., Cannon, D. S., von Niederhausern, A., Dunn, D. M., Matsunami, N., . . . Leppert, M. F. (2008). A candidate gene approach identifies the CHRNA%-A3-B4 region as a risk factor for age-dependent nicotine addiction. *PLoS Genetics, 4*(7), 1-11. doi:10.1371/journal.pgen.1000125

Wills, T. A., Knight, R., Sargent, J. D., Gibbons, F. X., Pagano, I., & Williams, R. J. (2017). Longitudinal study of e-cigarette use and onset of cigarete smoking among high school students in Hawaii. *Tobacco Control, 26*(1), 34-39. doi:10.1136/tobaccocontrol-2015-052705

World Health Organization. (2009). *Report on the scientific bassis of tobacco product regulation: Third report of a WHO study group.* Geneva, Switzerland: Author. Reterived from http://apps.who.int/iris/bitstream/10665/44213/1/9789241209557_eng.pdf

World Health Organization. (2014a). Countries vindicated cautions stance on e-cigarettes. Retrieved from http://www.who.int/bulletin/volumes/92/12/14-031214.pdf

World Health Organization. (2014b). Electronic nicotine delivery systems reported by WHO. Retrieved from http://apps.who.int/gb/fctc/PDF/cop6/FCTC_COP6_10-en.pdf

Yuan, M., Cross, S. J., Loughlin, S. E., & Leslie, F. M. (2015). Nicotine and the adolescent brain. *Journal of Physiology, 593*(16), 3397-3412.

Zhu, S. H., Sun, J. Y., Bonnevie, E., Cummins, S. E., Gamst, A., Yin, L., & Lee, M. (2014). Four hundred and sixty brands of e-cigarettes and counting: Implications for product regulation. *Tobacco Control, 23*, iii3-iii9.