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ELECTRONIC NICOTINE DELIVERY SYSTEMS (ENDS):
REASONS FOR USE AND ASSOCIATED FACTORS IN
SELF-SELECTED NICOTINE CONCENTRATIONS

A Thesis Presented for the Master of Science Degree

The University of Mississippi

May 2019

David D. Allen III, BA

Department of Pharmacy Administration

University of Mississippi, School of Pharmacy

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ABSTRACT

Introduction

This study aimed to examine e-cigarette user reasons for use, changes in their nicotine concentrations, and factors associated with changes in their chosen nicotine concentrations.

Methods

Data was from a convenience sample of 788 adult e-cigarette users recruited in Mississippi, examining user demographics, current/history of use, and their perceptions. 396 (34.64%) participants submitted a survey. Forty participants were excluded. The final sample was 356 for analyses.

Results

Participants had a mean e-cigarette time of use of about 24 months, a mean current nicotine concentration level of 7.767 mg/ml, and a mean initial nicotine concentration level of 8.851

mg/ml. About 56% were using their e-cigarettes for a harm reduction reason. Participants had a mean decrease of 1.084 mg/ml of their self-selected nicotine concentration ($t=-1.747$, $p=0.082$). Both linear regression models significantly explained the variance in the self-selected nicotine change score.

Conclusions

Participants reported a decrease in selected nicotine concentration. Total time of e-cigarette use was a significant predictor within the two linear regression models on the self-selected nicotine concentration change score, where increases in time of use were associated with greater decreases in the nicotine concentration change score. Vapers utilizing the e-cigarettes for harm reductions reasons had a greater decrease in the nicotine concentration change score than vapers using their e-cigarette for non-harm reduction reasons. Our findings reflect the existing literature and suggests that vapers will decrease their nicotine. Our study highlights the importance for additional research around changes in self-selected nicotine concentrations, and the use of e-cigarettes for harm reduction or smoking cessation purposes.

DEDICATION

This work is dedicated to Barbara “Nannan” Dotson Allen, my grandmother. You are in our hearts and I wish you were still here to see where your grandchildren have gone.

ACKNOWLEDGEMENTS

I would like to thank the electronic cigarette supply stores in central and northern Mississippi who allowed us to conduct participant recruitment in their businesses. I would like to thank my Thesis Committee, Dr, Yi Yang (Chair), MD, PhD, Dr. John P. Bentley, BSpH, MBA, MS, PhD, FAPhA, Dr. Meagen M. Rosenthal, MA, PhD, and Dr. Sandra I. Bentley, PharmD. DDA3 and YY conceived the study. DDA3 and three University of Mississippi Pharmacy Students conducted the participant recruitment in central and northern Mississippi. DDA3 conducted the initial data management; conducted the analysis under supervision from YY, and JPB; wrote the first draft; and revised the article based on feedback from YY, JPB, MMR, and, SIB. I would also like to acknowledge The Department of Pharmacy Administration, University of Mississippi, for their continued support, and Dr. David D. Allen II, University of Mississippi, School of Pharmacy, for providing feedback on the article to aid in revisions.

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CHAPTER 1

INTRODUCTION

Of the more than 4,000 chemicals in tobacco, nicotine is thought to be the major reasons for tobacco dependence. The United States (U.S.) Centers for Disease Control and Prevention (CDC) reports that tobacco use is associated with over 480,000 deaths each year across the U.S., making it the largest cause of preventable mortality.¹⁻³ While smoking prevalence has steadily decreased in the U.S. since 2005 from 20.9% of adults to 15.1% of adults, about 36.5 million adults, in 2015, there is still room for improvement.² The decline in smoking prevalence is expected to continue as 68% of smokers indicated they wanted to quit smoking entirely in a 2015 CDC survey.²

The U.S. Food and Drug Administration (FDA) has approved two categories of smoking cessation pharmacotherapies: nicotine replacement therapy (NRT), and non-nicotine medications.⁴ NRT medications cover drugs intended to manage nicotine withdrawal side effects by providing controlled doses of nicotine. NRT can be found in different forms, including nicotine patches, nicotine lozenges, or nicotine gum. While non-nicotine cessation medications act on neurotransmitters in an effort to safeguard patients from the same side effects.⁴ Non-nicotine medications include Chantix and Zyban.⁴

Chantix has been shown to have the greatest positive impact on cessation, among FDA approved cessation methods. Garrison et al. found that Chantix had success rates ranging from 21.9% to 34.6% in various studies.⁵ Zyban, nicotine lozenges, and nicotine patches have been shown to have success rates of 16.8%-23.1%, 19.9%, and 17.7% respectively.^{6,7} However, smoking cessation clinical trials usually report greater rates of cessation due to the controlled environments they can provide or encourage, with actual success rates around 10% lower than reported.⁸ In addition to methods approved by the FDA, there are other approaches smokers use to aid in their quit attempts.

Electronic cigarettes (e-cigarettes) use has increased at an alarming rate since their introduction in the U.S. in 2007. Originally developed by pharmacist Hon Lik, e-cigarettes commonly use a battery powered heating element to vaporize and deliver an aerosolized nicotine solution to be inhaled by the user.⁹⁻¹³ E-cigarettes offer a unique nicotine delivery mechanism which has encouraged the public to develop a widespread belief that e-cigarettes have potential to aid in smoking cessation.^{10,11,14-20} Rahman et al. explored this belief, reporting about an 18% cessation rate at the six-month follow up.¹⁵ This success rate is similar to that of NRTs, and Zyban, which are currently approved by the FDA for use in tobacco cessation.^{6,7} In addition, Nutt et al. conducted a relative harm analysis concluding e-cigarettes were 96% less harmful than conventional cigarettes (CC) when evaluating the potential harm to their users and bystanders.²¹ E-cigarette users have also reported the belief that e-cigarettes may inhibit nicotine cessation, while previous literature has reported they can cause side effects, and expose individuals to various chemicals at levels higher than recommended by the U.S. Environmental Protection Agency.^{8,9,11,16,22,23}

Previous research has explored the characteristics of use among electronic cigarette users, and the reasons behind these characteristics: showing over 80% of electronic cigarette users are using their devices with smoking cessation as their main reason for use.¹⁷ Electronic cigarette users themselves have proposed that electronic cigarettes can help users quit by allowing them to reduce their e-cigarette nicotine concentration over time.^{16,18,23} Soule et al. reported e-cigarette users agreed that tapering down their nicotine concentration helped them quit tobacco.²³ Current literature has not shown any connections between e-cigarette users' reasons for using e-cigarettes and their chosen nicotine concentrations. More research is needed to inform the public and policy makers on the trends around the use of e-cigarettes and how their use can affect public health.

This study utilized the Health Belief Model as the theoretical framework; concepts including, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy were used to represent portions of an individual's intent to complete or initiate an action or behavior.²⁴⁻²⁹ These concepts are complex in nature, initially being influenced by various factors of a person's demographic background that affect how each individual values each of the constructs.^{24,26} Due to the complex nature of smoking cessation and e-cigarette use, subjective norms was used to account for the impact of each individuals' social influences.³⁰

This study aimed to answer the following questions to provide evidence to policymakers, and researchers regarding e-cigarettes and smoking cessation. What are the reasons for use among electronic cigarette users? Do electronic cigarette users change their nicotine concentrations to help with smoking cessation? Which factors serve as predictors of change in

current electronic cigarette users' chosen nicotine concentrations in their electronic cigarette liquid?

The aims of this study were modified, upon completion of the first round of data collection, to answer the following questions to provide evidence to policymakers, and researchers regarding e-cigarettes and smoking cessation. What are the reasons for use among electronic cigarette users? Do electronic cigarette users change their nicotine concentrations? Which factors are associated with change in electronic cigarette users' chosen nicotine concentrations in their electronic cigarette liquid?

CHAPTER 2

LITERATURE REVIEW

Food and Drug Administration's Recent Announcement on Tobacco Regulations

In July of 2017, the United States (U.S.) Food and Drug Administration (FDA) released an announcement detailing a shift of their regulations on tobacco and related products.³¹ The FDA detailed its main goals as protecting children from smoking and reducing morbidity and mortality associated with tobacco utilization.³¹ A major component of this announcement described aims to begin a discussion on reducing nicotine levels in cigarettes to non-addictive levels.³¹ The FDA also intends to limit the introduction of new tobacco and electronic nicotine delivery system (ENDS) products by establishing end dates for new products in August 2021 for combustible tobacco products and August 2022 for ENDS products.³¹ A 2015 study by Grebenstein et al. demonstrated using lab rats, that lowering the level of nicotine in cigarettes would lead to a brief increase in the amount of cigarettes utilized but would result in lower usage levels subsequently.³² Benowitz and Henningfield discussed current studies around lowering nicotine concentrations in cigarettes with the general consensus that lowering nicotine levels could reduce nicotine exposure while not increasing cigarette consumption or could reduce nicotine dependence.³³ Sofuoglu and LeSage reviewed current literature on reducing cigarette

nicotine levels to at or below the reinforcement threshold, showing that the plan could work, but should be carried out over a longer period of time.³⁴ They concluded that additional research was needed to better inform policy recommendations.³⁴

The FDA's plan could potentially reshape the current tobacco epidemic through a series of changes, by encouraging current smokers to quit, and preventing future generations from picking up smoking. By preventing the introduction of new products and lowering the nicotine levels to non-addictive levels, the U.S. could see large movements of smokers switching to alternative products to either continue or taper off their addictions. Under these new time restrictions for the introduction of tobacco and ENDS products, continued research needs to be carried out to monitor all related changes and trends. ENDS research has continually increased since their introduction however, understanding the individual and societal impacts of these products is paramount from a public health standpoint. This study intends to collect data on ENDS use to better inform policy creation.

Tobacco and Nicotine Addiction

The U.S. Centers for Disease Control and Prevention (CDC) reports that tobacco use is associated with over 480,000 deaths each year across the U.S., making it the largest cause of preventable mortality.¹⁻³ Smoking prevalence has steadily been on the decline in the U.S. since 2005, from 20.9% of adults to 15.1% of adults in 2015, about 36.5 million adults.² The decline in smoking prevalence is expected to continue as 68% of smokers indicated they wanted to quit smoking entirely, in a 2015 CDC survey.²

Of the more than 4000 chemicals in tobacco, nicotine is thought to be the major reason for tobacco dependence.^{6,35} When nicotine is absorbed in the human body, it acts on hormones

and neurotransmitters including dopamine, serotonin, norepinephrine, acetylcholine, vasopressin, and beta-endorphins.^{6,36} Nicotine affects the central nervous system by increasing alertness, improving memory, improving concentration, and decreasing anxiety.^{6,36} These effects provide a temporary calming and euphoric high, producing a strong addiction to nicotine in a short timeframe.^{6,36}

Due to the nature of the addiction, tobacco dependence is considered a chronic relapsing disease.^{6,36} Achieving smoking cessation is as difficult as quitting alcohol, cocaine, or heroin, with multiple relapses expected throughout the process.^{6,35} Smokers looking to quit have pharmacologic, and/or behavioral options to help them achieve success and combat some withdrawal symptoms they may experience, including increased irritability or anxiety, new or worsening depression, weight gain, increased appetite, cravings to keep using tobacco, trouble sleeping, or difficulty thinking.^{4,35} If successful in their cessation attempt, former tobacco users will also benefit from lower risks for cardiovascular disease, respiratory disease, and various types of cancer.³⁵

Food and Drug Administration Approved Smoking Cessation Methods and Their Effectiveness

The FDA has multiple approved pharmacologic agents to aid in smoking cessation; in addition, there are other interventions that smokers may find helpful in their quit attempts, such as counseling, cognitive behavioral therapy or other behavioral interventions.⁴ There are two categories of pharmacologic cessation aids, nicotine replacement therapies (NRT) and non-nicotine medications.^{4,35} Over-the-counter NRTs include nicotine patches (also available with a prescription), nicotine gum, and nicotine lozenges. Nicotine inhalers, and nicotine sprays are available with a prescription.^{4,35} Non-nicotine pharmacologic cessation agents include Chantix (varenicline tartrate), and Zyban (bupropion hydrochloride), both of which are available with a

prescription.^{4,35} Behavioral therapies have also been shown to improve success rates associated with quitting tobacco products.^{6,35,36}

Chantix has been shown to have the greatest positive impact on cessation, among FDA approved cessation methods. Garrison et al. found that Chantix had success rates ranging from 21.9% to 34.6% in various studies.⁵ Zyban, nicotine lozenges, and nicotine patches have been shown to have success rates of 16.8%-23.1%, 19.9%, and 17.7% respectively.^{6,7} Smoking cessation clinical trials usually report greater rates of cessation due to the controlled environments they can provide or encourage, with actual success rates being around 10% lower than reported.⁸ In addition to cessation methods approved by the FDA, there are other approaches smokers use to aid in their quit attempts. Recent trends have shown a widespread belief that electronic cigarettes (e-cigarettes) have potential to aid in smoking cessation.^{10,11,14-20} Simmons et al. conducted focus groups with current and former smokers on their beliefs surrounding e-cigarettes with their participants reporting they greatly benefited from their use, as a cessation aid, in addition to seeing improvements in their health.¹⁸ A recent study conducted by Ayers et al. reported that the most prevalent reason for ENDS use, found in their Twitter content analysis, was quitting combustible tobacco products (43%, 95% CI (39-48)).¹⁹

Electronic Cigarette History and Regulations

E-cigarettes, or ENDS, are battery-operated devices designed to be used to inhale an aerosol solution typically containing nicotine. The history of electronic cigarettes can be traced back to 1962, when Herbert Gilbert initially developed a tobacco-less smoking device that would produce a non-nicotine vapor to be inhaled by the user.³⁷ Gilbert's precursor to modern e-cigarettes never achieved commercial success and failed to enter the market.³⁷ Modern e-cigarettes were developed by Chinese pharmacist Hon Lik and received the first patent on his

device in China during 2003.^{9-13,38} International and U.S. patents came later in 2007.^{9,39} As a previous pack a day smoker, Hon Lik developed ENDS to help himself and others achieve tobacco cessation after his father passed away from smoking-related lung cancer.¹³

In the U.S., the most recent regulations regarding e-cigarettes and related products came from the FDA in 2016.⁴⁰ The FDA moved e-cigarette products under their tobacco regulations.⁴⁰ This move set the minimum age to purchase e-cigarettes to 18 across the U.S. and allows the FDA to regulate the, “manufacture, import, packaging, labeling, advertising, promotion, sale, and distribution,”⁴⁰ of e-cigarette products.⁴⁰ Some states, like Hawaii in 2016, have opted to increase the minimum age of purchase and/or ban e-cigarette usage in public places.⁴¹ Outside the U.S., countries have taken varying approaches to e-cigarettes. Some countries such as Australia, Brazil, Canada, Mexico, Panama, Singapore, and Switzerland have opted to outright ban e-cigarettes.⁹ However, the United Kingdom’s (U.K.) Medicines and Healthcare Regulatory Agency announced a plan to regulate e-cigarettes as smoking cessation medication in 2014.¹² The U.K. offers e-cigarettes in the same fashion they do as NRT products, in that they are covered under their national healthcare system as a smoking cessation medication.¹²

Electronic Cigarette Terminology, Components, and Fluid

E-cigarette users, or ‘vapers’ as they prefer to be called, can purchase a variety of ENDS, including cig-alike, e-cigarettes, electronic pipes, electronic cigars, disposable vapes, hookah pens, and vape mods (highly customizable e-cigarettes).^{18,40,42} Whichever version of ENDS a vaper may use, they do share a few common qualities. Each ENDS utilizes a battery or multiple batteries to power a heating element, referred to as an atomizer, which vaporizes the fluid contained in the tank/reservoir to produce a cloud of vapor for the user to inhale.^{9,39,40,42} Each part of the more customizable e-cigarettes can be interchanged to create different setups. The

original cig-alike e-cigarettes utilized an airflow sensor to initiate vaporization while newer models use a button clicked and held by its user.⁹ The fluid vaporized by the ENDS usually contains some mixture of propylene glycol , glycerin, nicotine, natural/artificial flavorings, and occasionally water.^{9,38,40,42-44}

Bahtnagar et al. reported as of 2014 that there were 466 brands, and 7,764 unique flavors of e-juice in e-cigarettes.⁹ These numbers are expected to increase as the ENDS industry and consumer base continues to grow. Some e-cigarettes allow the user to adjust the voltage/wattage (VW) the device will produce. Higher VW increases the temperature the coil in the atomizer will reach, which can increase the volume of e-cigarette juice vaporized, adjust the flavor profile. Decreasing the VW can increase battery life or adjust the flavor. The nicotine concentrations in e-cigarette fluid ranges from 0 mg/ml to ~50 mg/ml.^{18,23} Hajek et al. reported that the most popular nicotine concentrations utilized by vapers was around 18 mg/ml.¹¹ In a more recent study, Soule et al. reported 8 mg/ml being the most popular e-cigarette nicotine concentration used by vapers.²³

Electronic Cigarette Safety and Potential for Dependence

Current literature reports e-cigarettes are at least 95% less harmful than convention cigarettes (CC) and the public would benefit from smokers switching from CC to e-cigarettes.^{9,14,21,45,46} For example, Nutt et al. conducted a relative harm analysis concluding e-cigarettes were 96% less harmful than CC when evaluating the potential harm to their users and bystanders.²¹ While less harmful than CC, e-cigarettes are not safe and can produce hazardous substance that users inhale.^{9,11,21,45} Chen et al. reported e-cigarettes exposed users to average levels of acrolein and propylene glycol were higher than recommended by the U.S. Environmental Protection Agency's guidelines.⁴⁵ In addition, emissions maximum exposure

levels of diethylene glycol, and cadmium were at levels higher than the Environmental Protection Agency's guidelines.⁴⁵ Hajek et al. evaluated a study completed in Japan, suggesting that e-cigarettes are exposing users to formaldehyde at levels 5 to 15 times that of CC.¹⁴ A later study published in the *New England Journal of Medicine* followed up on the previous claim finding negligible formaldehyde levels at lower e-cigarette power settings, lower VW.¹⁴ Formaldehyde was detected at higher power levels or in e-cigarettes with low fluid, however vapers are able to instantly detect this phenomenon due to a harsh and acrid taste, prompting them to refill their e-cigarettes or turn down the power.¹⁴

Bhatnagar et al. reported vapers may also be exposed to different particulates, including tin, iron, nickel, chromium, ceramics, plastics, rubber, or foams when using e-cigarettes.⁹ The metals could come from the type of metal the coil in the atomizer is made. Some e-cigarettes can control their power output in terms of VW, while some can also control the exact temperature to which they heat specific metals. To provide an example of this, the Reuleaux RX200 can control temperatures of the coil if it is made from titanium, stainless steel, or nickel in addition to controlling the VW it produces.⁴⁷

In a 2014 study, Polosa et al. reported common adverse events related to e-cigarette use at 4, 8, 12, and 24-week follow-ups. Adverse reactions included, throat/mouth irritation (35.6%), dry throat/mouth (28.9%), headache (26.7%), and dry cough (22.2%) at the 4-week follow-up.⁸ The prevalence of these adverse events generally declined over time, with 10.5%, 18.4%, 21.2%, and 5.3% reporting the same events at the 24-week follow-up, respectively.⁸ Other adverse events included dizziness, nausea, sore throat, palpitations, and a choking sensation at lower prevalence rates.^{8,48}

The early versions of disposable e-cigarettes released in Poland, the U.K., and the U.S. had varying efficiencies at vaporizing the nicotine they contained.³⁸ Goniewicz and colleagues studied 16 types of e-cigarettes in their ability to vaporize the nicotine they contained, showing the e-cigarettes studied vaporized between 21% to 85% of the nicotine they contained after 300 puffs.³⁸ Goniewicz et al. also showed that the labeled nicotine concentrations in some brands may be significantly different from their actual nicotine concentrations.³⁸ With the advancement of the e-cigarette industry, improved standards have been set up as well as the improvement of the various e-cigarette types. The ability and efficiency of an e-cigarette to vaporize its nicotine may affect vaper dependence.⁴³ The same applies to CC and NRT in their delivery methods and levels of nicotine exposure.⁴³ Etter and Eissenberg conducted a study to evaluate dependence levels of e-cigarette, nicotine gum (NRT), and CC users. They found that CC are by far the most addictive delivery method with e-cigarettes being about addictive or potentially less addictive than nicotine gum.⁴³ Goldenson et al. reported on high school student use of e-cigarettes, finding that higher levels of e-cigarette nicotine concentrations increased the odds for participants to still be vaping at the 6 month follow up.⁴⁹

Electronic Cigarette Populations Statistics and Economics

The U.S. has seen rapid economic growth in the e-cigarette market, with sales having almost doubled each year since 2008.^{9,10,50} In 2014, the CDC reported that about 3.7% of American adults currently used e-cigarette, with 12.6% of adults having ever tried them.² The CDC reported on the prevalence of electronic cigarette use for 2014 showing men (4.1%) have a higher rate of use than women (3.4%).⁵¹ Adults age 18-24 (5.1%), and age 25-44 (4.7%) have higher rates than adults age 45-64 (3.4%) and 65+ (1.4%).⁵¹ Non-Hispanic whites (4.6%), and American Indians/Alaskan Natives (10.7%, 95% CI [5.3, 20.4]) use e-cigarettes at a significantly

greater rate than non-Hispanic black (1.8%), non-Hispanic Asian (1.5%), and Hispanic (2.1%) subgroups.⁵¹ Current smokers (15.9%), recent former smokers (22.0%), and long term former smokers (2.3%) have higher rates of current use of e-cigarettes when compared to those who never smoked cigarettes (0.4%).⁵¹

Xu et al. reported that the sales of electronic cigarettes reached \$12 million in 2011, \$22 million in 2012, and \$28 million in the second quarter of 2013 in the U.S.¹⁰ Correspondingly, the CDC reported e-cigarettes sales increased about 320% for disposable e-cigarettes, 72% for starter kits, and 82% for cartridges between 2012 and 2013.⁵⁰ Wells Fargo has predicted global sales for e-cigarettes could grow to \$10 billion by 2017.⁹ With the increasing market and consumers of e-cigarettes, e-cigarettes have become a focus point for scientific inquiry. Xu reported on the growth of e-cigarette related articles in PubMed from less than 100 in 2012, to more than 200 in 2013, and 800 in 2014.^{10,52} We conducted our own search of PubMed with the search terms ‘electronic cigarette’, ‘e-cigarette’, ‘e-cig’, ‘electronic vaping device’, ‘personal vaping device’, ‘electronic nicotine’, ‘electronic nicotine delivery system’, ‘electronic hookah’, ‘electronic cigar’, ‘cig-alike’ or ‘vaper,’ in the titles of articles. Our PubMed search occurred at the beginning of October 2017 and found 1,041 search results.

Electronic Cigarettes Reasons for Use and Surrounding Opinions

Various reasons for use of e-cigarettes have been provided by vapers, smokers, ex-smokers, and non-smokers. Tobacco cessation is a well discussed reason for e-cigarette use, with many respondents reporting they decrease their e-cigarette fluid nicotine concentration over time.^{10,16–19,23,44,53,54} However, more research is still needed to examine the safety and effectiveness of e-cigarettes as a cessation aid and their overall public health impact before policy and health recommendations can be made.

Tobacco reduction usually involves dual-use of e-cigarettes and some form of tobacco, like cigarettes or cigarillos, but is a hazard to the user's health due to the continued use of tobacco.^{16,17,23,44} While this method is a matter of concern, Carpenter et al. and Hammond et al. have reported NRT has been used with the same strategy.^{55,56} Tobacco reduction usually uses nicotine products to reduce or eliminate side effects of tobacco/nicotine withdrawal, if the user has to go an extended period without their tobacco product, like at work, or on commercial airline flights. Tobacco replacement or tobacco relapse prevention employs e-cigarettes as a substitute for tobacco products and is another common reason for use reported by vapers.¹⁶ Tobacco replacement or relapse prevention is another reason for use common with NRT.^{16,55}

Some vapers use e-cigarettes to circumvent public smoking laws as most smoking bans don't include e-cigarettes, another strategy associated with NRT products as well.^{19,23,44,55} This is not the case on commercial airlines, as the U.S. Transportation Security Administration and individual airline companies, like Delta Airlines, do not allow e-cigarette use onboard commercial flights and e-cigarettes must be carried in carry-on baggage.^{57,58} Recreational use has also been cited as a reason to use e-cigarettes, this is a cause for concern that will require additional research on how to curb this phenomenon.^{23,44,45,53}

Respondents from various studies have shared their opinions related to the perceived benefits associated with e-cigarettes. Perceived benefits for e-cigarettes include a sense of belongingness in the vaping community, allowing vapers to keep their social surroundings even if their peers use tobacco, recreating reinforcing habits associated with smoking (personal cues, hand to mouth, social, drinking, etc.), reducing their withdrawal symptoms with nicotine like NRT, decreasing/tapering their nicotine concentrations to quit at their own pace, and the variety of available flavors which enable them to stay away from tobacco and menthol flavors.^{16-19,23,46}

Studies have also reported that some respondents believe e-cigarettes are less harmful and healthier than CC in addition to other forms of tobacco products.^{10,16–18,20,23,44,59,60} Etter reported participants who were using e-cigarettes to quit smoking, believed they were “better for (their) health than tobacco.”⁴⁴ Opposing to the reported perceived benefits, vapers have also reported perceived risks associated with e-cigarettes, in that they could hinder a smoker from attaining cessation by potentially maintaining nicotine addiction, the persistence of a craving for tobacco, exposing e-cigarette users to carcinogens, and other unknown long-term adverse health effects.^{16,23}

Electronic Cigarettes and Smoking Cessation

E-cigarettes have been promoted as a smoking cessation aid in marketing and advertising campaigns by their manufacturers, and distributors.^{10,12,16,61} Grana et al. reported 64% of e-cigarette advertisements contained claims related to smoking cessation.⁶¹ In comparison, Wackowski et al. reported 84% of vapers use e-cigarettes as a cessation method.¹⁷ Rahman et al. developed a meta-analysis of six studies detailing the effect of e-cigarettes on smoking cessation and reported an 18% cessation rate by the six-month follow up.¹⁵ This success rate is similar to that of NRTs, and Zyban.^{6,7} Polosa et al. conducted a pilot study in 2011 and a clinical trial in 2014 examining CC use reduction associated with e-cigarette use.^{8,48} The pilot study reported approximately 81% of participants sustained a 50% or greater reduction in CC use while using e-cigarettes at 24-weeks follow-up with one-third having achieved complete cessation.⁴⁸ Their clinical trial reported 86% of participants sustained a 50% or greater reduction in CC use at 24-weeks follow-up and about 47% achieved complete cessation.⁸ Polosa et al. concluded as a tobacco harm reduction strategy, e-cigarettes are a realistic and promising method.⁸ However, both studies started with small samples (n=40, n=50, respectively) and lost participants by the

24-week follow up.^{8,48} The pilot study lost 13 participants while the clinical trial lost 12 participants.^{8,48}

A systematic review examined four e-cigarette clinical trials, and concluded that nicotine-containing e-cigarettes are not an efficacious method for smoking cessation.¹² The review states that non-nicotine placebo e-cigarettes may be useful as a substitute of the sensory and behavioral aspects of smoking.¹² One recent systematic review and meta-analysis conducted by El Dib et al. of e-cigarette randomized control trials concluded that there is very limited evidence on the impact or efficacy of e-cigarettes in smoking cessation.⁶² The authors reported these trials did not adhere to a standard definition of smoking cessation with each study employing a different definition and stressed that future e-cigarette trials need to be well-designed and biochemically validated outcomes need to be measured.⁶² Future studies in e-cigarette research should employ a standard definition of smoking cessation and trials need to take into account the opinions and experiences of current vapers and vapers who successfully terminated their tobacco addiction.

Electronic Cigarette Gradual Reduction and Personalized Nicotine Concentration Strategies

Research on reasons to use e-cigarettes have reported users believe that e-cigarettes can help combat a smoker's addiction to nicotine or tobacco through a gradual reduction in their e-cigarette fluid nicotine concentration. This strategy has been proposed as a means to end cigarette smoking at a policy level, by implementing legal limits on the nicotine contained in CC.^{31,32,34,63,64} Benowitz et al. conducted a study on tapering nicotine concentrations in CC and found the participants experienced reduced adverse effects with 25% of their participants (n=20) achieving cessation even though they didn't enter the study to quit.^{64,65} Benowitz et al. employed nicotine tapering from cigarettes containing 12mg of nicotine down to 1mg of nicotine over a 10 week period showing that nicotine reduction strategies using e-cigarettes could be beneficial to

their users.^{64,65} Beginning a smoker's cessation attempt on a standardized level of nicotine may not produce ideal outcomes for every individual. Every smoker varies in their use of CC or other tobacco products which might necessitate a more customized cessation plan. Rose et al. has proposed a personalized smoking cessation strategy tailored to each individual.⁶⁶ This strategy could be useful as cigarettes have been known to have different levels of nicotine, and not every cessation method works for every person, as shown by the success rates between 16% and 35% of NRT, Zyban, and Chantix.^{5-7,67}

Soule et al. surveyed vapers on their reasons for using e-cigarettes, finding that vapers primarily use e-cigarettes for smoking cessation but there are many other reasons for their use.²³ In this study, the perceived benefit of e-cigarettes to taper or reduce nicotine concentrations over time was rated an average of 5.49 on a scale from 1 to 7.²³ Other qualitative studies have also reported that vapers decrease their nicotine concentration in their e-liquids over time. For example, Simmons et al. conducted a series of focus groups on vapers perceptions and intentions for future use.¹⁸ A theme obtained from the groups was that users were intentionally trying to reduce the amount of nicotine in the e-cigarettes they used, and reported success in doing so obtaining some of the lowest nicotine concentrations for the brands they used.¹⁸ Camenga et al. conducted 18 focus groups with an emergent theme of 'Methods for Smoking Cessation' containing a prevalent belief that 'e-cigarette users could gradually reduce or "wean" nicotine dosage,' and that smokers may benefit from this elongated process.¹⁶ However, little information is available regarding the extent of vapers' chosen nicotine concentration changes over time and what characteristics of individual users affect the choices made regarding vapers' chosen nicotine concentrations over time.

Theoretical Framework

The Health Belief Model (HBM) has become one of the most widely used behavioral frameworks, since its introduction in the early 1950s.^{24-26,29} This model has been employed extensively in studying personal health behavior and behavioral changes as it provides an explanation of how an individual's beliefs affect their choice to engage in or change a health behavior.^{24,26} There are six central concepts within the HBM including perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy.²⁴⁻²⁹ These concepts each represent portions of an individual's intent to complete or initiate an action or behavior. Perceived susceptibility and perceived severity are interlinked in perceived threat with susceptibility referring to an individual's perceived risk to a negative effect and severity describing the belief of how serious the negative effect is.^{24,26,29} Vapers can identify their risk for a side effect from vaping and how serious they believe that side effect is. Perceived benefits are the positive outcomes of the action or behavior, while perceived barriers are the costs and negative predispositions associated with the action or behavior.^{24,26,29} Vapers could see less side effects and more control over their addiction using e-cigarettes when compared to CC or they could have a negative view on e-cigarettes. Cues to action involve different methods to get a person ready to carry out the action or behavior with self-efficacy being the person's belief in their ability to carry out the action or behavior.^{24,26,29} A vaper's support system, might be inclined to provide a cue to action if they support the use of an e-cigarette for CC cessation. A vaper's internal motivation to change a behavior can affect their actions taken to change that behavior, vapers with more motivation to quit smoking CC, may be more inclined to change their nicotine concentrations faster.

These central concepts of the HBM are influenced by a combination of the individuals' socioeconomic and demographic characteristics, in that a person's background will affect how they value and perceive each of the constructs.^{24,26} The HBM does not have an emphasis on social norms and the influence of an individual's peers.²⁹ Due to the complex nature of smoking cessation and e-cigarette use, social influences in the form of subjective norms will also need to be considered. Subjective norms cover the normative beliefs of people around the individual in question in addition to the individual's value of the referred person, the closer a peer is to the individual, the more importance or weight the individual might place on the peer's opinion.^{29,30}

Intentions of smokers, ex-smokers, and vapers can be described with the HBM, with each of the six concepts represented in tobacco or e-cigarette use. Mohammadi et al. and Reisi et al. have conducted studies utilizing the HBM to predict the actions of smokers under the age of 18, showing that perceived susceptibility, perceived benefits, perceived barriers, and self-efficacy are all related to tobacco use.^{27,28} Reisi et al. reported that smokers and non-smokers have significant differences in perceived susceptibility ($p=0.03$), perceived benefits ($p=0.01$), self-efficacy ($p<0.001$), and cues to action ($p=0.007$).²⁷ Mohammadi et al. conducted a study of the HBM related to smoking and reported self-efficacy, and cues to action as significant predictors of smoking behavior.²⁸ This study will utilize the HBM with the addition of subjective norms as a theoretical framework to identify predictors of change in vapers' chosen nicotine concentrations in their e-cigarette liquid. A diagram of our theoretical framework can be found in Appendix B.

Implications for Research

E-cigarette use has increased at alarming rates since their introduction in the U.S.² Researchers and their respondents have expressed concern regarding the use of e-cigarettes as a potential gateway to CC or other tobacco products. As with Hon Lik's original intention for e-cigarettes, research has shown that a majority (84%) of vapers use e-cigarettes for smoking cessation purposes.¹⁷ However, more research on the reasons for e-cigarette use and the extent of e-cigarette use is needed to better understand their short-term and long-term impact on public health. Since the FDA's July 2017 announcement on plans to discuss nicotine levels in CC, smokers may be more motivated to begin to lower their nicotine levels at a more controlled rate and could be drawn to NRT, or to e-cigarettes. This potential 'migration' of smokers to NRT and e-cigarettes accentuates the importance for more research on the patterns of use with these products and research to help inform the development of personalized smoking cessation strategies tailored to each individual.

Original Objectives

In this study, we aim to:

- Determine the reasons for electronic cigarette use amongst current electronic cigarette users.
- Describe changes in current electronic cigarette users' chosen nicotine concentrations in their electronic cigarette liquid over a six-month period.
- Identify predictors of change in current electronic cigarette users' chosen nicotine concentrations in their electronic cigarette liquid.

Modified Objectives

In this study, we aimed to:

- Determine the reasons for electronic cigarette use amongst current electronic cigarette users.
- Describe changes in current electronic cigarette users' chosen nicotine concentrations in their electronic cigarette liquid.
- Identify factors associated with change in current electronic cigarette users' chosen nicotine concentrations in their electronic cigarette liquid.

CHAPTER 3

METHODS

Hypotheses

Based on a review of the literature in smoking cessation and electronic cigarette use, we hypothesized that (1) the majority of vapers are using electronic cigarettes with smoking cessation as their main goal;¹⁷ (2) vapers will decrease their chosen concentration of nicotine ;^{16,18,23} (3) self-efficacy and cues to action will be the strongest factors associated with each vapers' change in their chosen nicotine concentrations over a six-month period.^{28,67}

Study Design

This study employed a cross-sectional survey, recruiting a convenient sample of electronic cigarette users. Participants are referred to as 'vapers' in this study, current literature shows they prefer to be identified with this term.¹⁸ Electronic surveys were utilized to collect data on the following elements: reasons for e-cigarette use, future e-cigarette use intentions, patterns of use, and constructs specified in the theoretical framework within electronic cigarette users at two time points during the study. The surveys also contained questions aimed at examining vapers' chosen nicotine concentrations, smoking cessation strategies, duration of use, frequency of use, history of cigarette use, history of other tobacco use, and future intentions of using electronic cigarettes. In addition, vapers' socio-demographic information was collected.

To track each vaper, their email address was acquired to distribute the survey. However, vaper date of birth, address, name, or other personally identifiable information was not collected to protect the respondents' identities. All collected personally identifiable information was maintained in a password protected laptop, or in a secure and undisclosed locked location. Only research team members have access to personally identifiable information. Confidentiality was further protected separating personally identifiable information from vapers' responses into a separate document. At the end of the study, all personally identifiable information will be deleted along with the email file to further protect the identity of vapers. Deidentified data will be maintained on secure files thereafter. This study has been approved by the University of Mississippi's Institutional Review Board.

Sample Population and Recruitment Strategy

This study utilized a convenience sampling strategy, producing a non-randomized sample. All results are reported as observed correlations as we cannot infer causality due to the sampling design. Recruitment was carried out in person by a research team member in central, and northern Mississippi vape shops. We gathered the majority of vapers in Oxford, MS to reduce any travel costs associated with the study. After participants were made aware of their rights as research participants, they were asked to give written consent, in the form of their email address, in order to participate in the study. Vapers' emails were used to link their responses on the survey with their consent forms. An example consent form can be found in Appendix C.

Necessary sample size was calculated using G*Power, finding that 165 participants will be needed to meet the analytical needs of this study at the second survey.⁶⁸ However, the literature shows that around 80% of users are using electronic cigarettes with cessation as a reason and about 60% of the initial sample remained in studies till completion. With these

adjustments, we proposed to recruit a minimum of 350 participants to maintain enough participants for statistical analyses at the time of the second survey.

The inclusion criteria for this study are individuals who are 18 years of age or older, and currently use an e-cigarette at the time of recruitment. Before being asked to participate in the survey, each person was provided with information on their rights as a research participant and asked to complete a consent form. Participants were excluded if they are under 18 years of age, report that they have never used an electronic cigarette before, did not currently use an electronic cigarette, or did not complete the survey through the demographic section. The emphasis on age is due to current Mississippi and federal legislation on e-cigarette use, setting the minimum age to purchase e-cigarette products to 18. Objective 3 utilized an additional exclusion criterion in that participants had to complete the questions related to this study's theoretical model. The inclusion and exclusion criteria were examined using the first three (3) questions of the initial survey. To show appreciation for their participation and to increase response rate, respondents were notified that they would receive a \$5 Amazon e-gift card sent via email after completing the survey.

Data Collection

Data collection was carried out via Qualtrics. The initial survey was emailed to the participant within 48 hours after the completion of their consent form. The survey was distributed from a University of Mississippi email address to each participant's provided email address. To boost the response rate, participants received two email reminders at one week and two weeks after the distribution email, if we did not have a response from their email address. In addition, the gift card reward for survey participation was expected to help increase the survey's

response rate. All data was stored on Qualtrics until it was transferred to a researcher's secure laptop.

Survey Development

The survey was developed in Qualtrics, under a license held by the University of Mississippi. The first question contained information on who to contact if the participant had any questions or trouble on/with the survey. The initial survey utilized its second, third, and fourth questions to filter out any participants who do not meet the inclusion criteria. This was carried out in a specific order to protect the identities of those participants who do not qualify to participate. The second question asked the age of the participant to verify they were of a legal age to use electronic cigarettes. The third question asked if the participant currently used electronic cigarettes as the survey was intended to assess current users of electronic cigarettes. The last inclusion/exclusion question requested the participants email address to link their responses to their consent forms.

Demographic questions were developed based on the CDC's National Youth Tobacco Survey and National Adult Tobacco Survey.^{69,70} Electronic cigarette and conventional cigarette history of use questions were developed based on questions in the National Youth Tobacco Survey and National Adult Tobacco Survey, specifically questions attempting to identify the duration of lifetime use and recent use the specified products.^{69,70} The CDC defines a smoker as someone who has smoked at least one CC in the last month and at least 100 CCs over their lifetime.⁷⁰ A question from the National Health Interview Survey was utilized to ask about tobacco cigarette use.⁷¹ The National Adult Tobacco Survey was used to determine if respondents meet the CDC definition of a smoker.⁷⁰ Questions regarding predictors of vaper's chosen nicotine concentrations in their e-cigarettes liquid were developed bases on the

theoretical framework of this study, a study by Kelley Rhoads, a study by Coe et al., and a study by Soule et al.^{23,72,73}

This survey contained 53 questions, of these nine were required questions: three were for the inclusion criteria, three asked about nicotine concentrations, two were on time frames associated with nicotine concentrations, and one asked about their reason for using e-cigarettes. This survey utilized skip logic to reduce the amount of questions a participant would have to complete when the questions were not applicable to the participant. If a participant had never smoked CC, then the survey would skip to the first question after the CC questions. There were some questions contained within the survey intended to inform future research questions or act as back up analyses in the event of a high sample attrition rate. These questions pertained to financial costs associated with e-cigarettes, volume of e-cigarette liquid use, vaper flavor preferences, and vapers beliefs on flavors impact on their tobacco quit attempts. The questionnaire was pilot tested with a small sample to check for face validity before deploying it to our main participants. An example survey can be found in Appendix C.

Study Variable Operationalization

The theoretical framework and current literature in smoking cessation and e-cigarettes informed the operationalization of variables contained in the survey. Sociodemographic variables of age (≥ 18 years), sex, race, ethnicity, and educational attainment were measured the survey.

The survey examined reasons for use using two primary questions and some additional follow up to confirm the participant uses their electronic cigarette as described. Participants were asked if they are using e-cigarettes for the following reasons: to circumvent smoking bans, to reduce how much they smoke CC, to switch their CC for their e-cigarette, to replace their CC for

their e-cigarette and reduce their nicotine, to quit another form of tobacco, to control their appetite/for weight loss, for fun, for a buzz/high, or other, with the option to insert their own answer on a follow up question.

Participants were asked their currently used nicotine concentrations in milligrams per milliliter (mg/ml), since this is the standard unit used in e-cigarettes. In addition, they were also be asked the nicotine concentration they used when they first started using their e-cigarette. Nicotine concentration will be referred to as nicotine level in the survey to allow the participants to see terminology they are familiar with.

A brief history of use in e-cigarettes and CC was determined through a series of questions designed to determine the duration and severity of use, in addition to two questions to determine if the smoker meets the CDC definition of a smoker. The history section asked participants about usage of e-cigarettes and CC among their family and friends. Peer use of either nicotine delivery system, served as a basis for the subjective norms in the theoretical construct. Participants' beliefs were looked at using a series of statements where the participant is asked to identify if they strongly agree to strongly disagree. Theses belief statements are listed in Appendix A and were utilized to represent the constructs from the theoretical model. Some of these statements were positively coded while others were negatively coded to examine the consistency of a respondent's answers.

Data Analysis

Descriptive statistics were conducted on the vapers' sociodemographic characteristics, e-cigarette characteristics of use, and CC characteristics of use, including frequencies and percentages. The e-cigarette characteristics included their reasons for use, future intentions for e-

cigarette use, their initial nicotine concentration, and their current nicotine concentration. Using the matched nicotine concentrations of each participant, a paired samples t-test was utilized to examine the differences between vapers' initial nicotine concentrations and their current nicotine concentrations. Two linear regression models were created to identify factors associated with changes in vapers' chosen nicotine concentrations. The first model contained the vapers' e-cigarette characteristics of use and their sociodemographic characteristics. The second model expanded from the first to include the factors from our theoretical model.

An Alpha of 0.05 was used to determine statistical significance. All t values are reported as two-tailed tests. Statistical analyses were conducted in IBM's SPSS 25.0, under a license held by The University of Mississippi.⁷⁴ Data collected in Qualtrics was downloaded in to an Excel file and then transferred in to SPSS.

CHAPTER 4

RESULTS

Total Sample and Exclusions

Upon completion of the survey collection, consent was received from a total of 788 individuals, of which 396 (34.64%) submitted a survey via Qualtrics. Thirty-three participants were excluded for not completing the survey through the demographics section. Two participants responded to the survey twice, their second responses were removed. Four participants were excluded due to their reported current nicotine concentration level not reflecting a mg/ml format. One participant was excluded due to an error in reported total time of e-cigarette use in months. The final sample was 356 for analyses. In addition, 14 participants were excluded from the linear regression models for not completing the questions related to this study's theoretical model.

Sample Characteristics

The sample was primarily male, white/Caucasian, non-Hispanic/Latino/a, and had started or completed their education past a high school degree. The average age of the study sample was 23.8 years. Participants had a mean e-cigarette time of use of about 24 months, a mean current nicotine concentration level of 7.767 mg/ml, and a mean initial nicotine concentration level of 8.851 mg/ml. The majority of participants planned to keep their nicotine concentrations the same

in the next 6 months, planned not to quit using their e-cigarette in the next 6 months, primarily used tank mod e-cigarettes, and used e-cigarettes to replace their CC use. Participants had a mean time of cigarette use of about 8 years and had a mean of about 3.2 quit attempts. Quitting ‘cold turkey’ or by their willpower alone was the predominant method of cessation utilized by participants with 185 (58.9%) having reported they attempted this method. Three-hundred and sixteen participants reported having ever used a cigarette, with 256 reporting they have used at least 100 cigarettes. Ninety-two participants met the CDC definition of a smoker with at least 100 cigarettes used in their lifetime and at least one used in last month. Table 1 presents the descriptives statistics of participants’ sociodemographic information. Table 2 presents the descriptives statistics of participants’ e-cigarette characteristics of use. Table 3 presents the descriptives statistics of participants’ CC characteristics of use.

Difference in Self-Selected Nicotine Concentration from Initial to Current E-Cigarette Use

Participants reported a mean initial nicotine concentration of 8.851 mg/ml and a mean current nicotine concentration of 7.767. Participants had a mean decrease of 1.084 mg/ml of their self-selected nicotine concentration in their e-cigarette nicotine solution from their initial use of e-cigarettes to their current use of e-cigarettes; however, this decrease was not statistically significant ($t=-1.747$, $p=0.082$). See Table 4 for the results of the paired samples t-test regarding the change in self-selected nicotine concentration from initial to current use of e-cigarettes.

Factors Associated with Change in Self-Selected Nicotine Concentration from Initial to Current

E-Cigarette Use

Main reason for e-cigarette use were collapsed from nine different options to three including, harm reduction (reduce cigarette consumption, replace cigarettes, replace cigarette and

reduce nicotine, and replace other form of tobacco), non-harm reduction (to circumvent smoking bans, for weight loss/control appetite, for fun, and for buzz/high), and other. Main type of e-cigarette used were collapsed from five option to two options including, customizable e-cigarettes (tank-mod e-cigarettes and drip mod e-cigarettes) and non-customizable e-cigarettes (cig-alikes, vape pens, and e-hookahs). Table 5 reports results of linear regression model examining e-cigarette use characteristics, CC use characteristics, and sociodemographic characteristics. The model explained 19.6% of the variance in the self-selected nicotine concentration change score. Collinearity statistics were within an appropriate range. E-cigarette time of use (months) was a significant predictor, with each one month increase in the time of e-cigarette use there was a decrease in nicotine concentration change score of 0.099 mg/ml. There was a significant difference between individuals using e-cigarettes for a non-harm reduction reason and individuals using e-cigarettes for a harm reduction reason. Vapers using e-cigarettes for non-harm reduction reasons had an increase of 3.273 mg/ml on the change score when compared vapers using e-cigarettes harm reduction reasons.

Table 6 reports results of the second linear regression model, which explained 23.2% of the variance in the self-selected nicotine concentration change score. Collinearity statistics were within an appropriate range. Model 2 includes all variables used in model 1 with the addition of the factors associated with change from our theoretical model. E-cigarette time of use (months) was a significant predictor, with each one month increase in the time of e-cigarette use there was a decrease in the nicotine concentration change score of 0.095 mg/ml. There was a significant difference between individuals using e-cigarettes for a non-harm reduction reason and individuals using e-cigarettes for a harm reduction reason. Vapers using e-cigarettes for non-harm reduction reasons had an increase of 3.087 mg/ml on the change score when compared

vapers using e-cigarettes harm reduction reasons. Self-efficacy was a significant predictor, with each one unit increase in the self-efficacy score, there was a decrease in the nicotine change score of 0.340 mg/ml. Perceived severity was a significant predictor in the model with each one unit increase in the perceived severity score, there was an increase in the nicotine change score of 0.239 mg/ml.

CHAPTER 5

DISCUSSION

In our sample of 356 adult vapers, about 56% were using their e-cigarettes for a harm reduction reason of reducing cigarettes, replacing cigarettes, replacing cigarettes and reducing nicotine concentration, or replacing another form of tobacco. The obtained sample for this study reflects the population of e-cigarette users in the U.S. as reported by the CDC.³⁷ The sample had a mean and median age of about 24 years, which matched the CDC's report showing the majority of users were age 18-44 years of age.³⁷ Participants reported a decrease in selected nicotine concentration; while this was not a statistically significant finding it does show that vapers are decreasing their self-selected nicotine concentrations.

Total time of e-cigarette use was a significant predictor within the two linear regression models on the self-selected nicotine concentration change score, where increases in time of use were associated with greater decreases in their nicotine concentration change score. Vapers utilizing the e-cigarettes for harm reductions reasons had a greater decrease in their nicotine concentration change score than vapers using their e-cigarette for non-harm reduction reasons. Individuals seeking harm reduction or smoking cessation may be more motivated to decrease their nicotine concentrations and consequentially their nicotine consumption and dependence.

Existing literature has discussed the perception of vapers that e-cigarettes can be utilized for smoking or tobacco cessation by replacing their tobacco product with an e-cigarette and changing their nicotine level over time to reach complete nicotine cessation. Our findings reflect the existing literature and suggests that vapers will decrease their nicotine concentrations to a lower level the longer they use their e-cigarette.

Self-efficacy was statistically significantly associated with decreases in the nicotine concentration change score. within our second regression model. Individuals who believe they can achieve smoking or nicotine cessation may be more motivated to decrease their self-selected nicotine concentrations. Perceived severity was statistically significantly associated with increase on the nicotine concentration change score. This does not reflect our initial hypothesis on perceived severity as we expected individuals experiencing more side-effects associated with e-cigarettes to have greater reductions in their nicotine concentrations. The remaining factors included in the theoretical framework of this study were not statistically significantly associated with the changes in nicotine concentrations for our participants. The scores for perceived barriers, and subjective norms were not significant predictors of the self-selected nicotine concentration change score however, they were associated with a decrease in nicotine concentration. While we pulled from existing surveys and literature, we did not use a validated questionnaire, and we used more general questions around e-cigarettes instead of questions specifically aimed at informing the nicotine change score to determine if the questions were measuring what they intended to.

To our knowledge this study is the first to examine changes in self-selected nicotine concentrations and factors associated with such changes, and our finding reflect current literature on the belief of vapers that they can reduce their nicotine concentrations.^{16-18,23} Our study

highlights the importance for additional research around changes in self-selected nicotine concentrations, and the use of e-cigarettes for harm reduction or smoking cessation purposes. Future studies should attempt to further understand the reasons and factors associated with change in vapers' self-selected nicotine concentration scores to provide additional information to the public and policy makers. These studies should attempt to use validated measures to obtain a clearer view of each factor's relationship with changes in vaper self-selected nicotine concentrations, specifically focusing on harm-reduction, self-efficacy, perceived barriers, and subjective norms.

Current literature is showing changes in the e-cigarette population towards nicotine salts e-cigarettes, like JUULs which accounted for about 40% (\$150 million) of e-cigarette sales in the fourth quarter of 2017.³⁹ JUULs and similar devices (like Sourin e-cigarettes) utilize a different form of nicotine from traditional e-cigarettes, higher nicotine concentrations than traditional e-cigarettes (35 mg/ml and 59 mg/ml), and have a striking appeal with a sleek, non-modifiable, closed system device that easier to use and maintain compared to tank mod or drip mod e-cigarettes.³⁹⁻⁴¹ Our survey obtained information on the types of e-cigarettes used and the self-selected nicotine concentrations used by vapers. Vapers within our sample reported nicotine levels associated with nicotine salts e-cigarettes and 26.2% of our sample reported using a vape pen or cig-alike e-cigarette.

Scott Gottlieb, the former FDA Commissioner, made a statement in early 2018 on the FDA's intent to prevent the use of JUULs and other e-cigarettes by youth.⁴² This statement also provides information of the FDA's plan considering the regulation of nicotine levels in cigarettes to minimally or non-addictive levels and suggests that e-cigarette may offer an alternative with potentially lower risk to adult smokers.⁴² In April of 2019, the FDA made a statement on a link

between e-cigarettes and seizures in youth and young adults, potentially associated with high levels of nicotine or the use of other substances.⁴³ Continued research is necessary around the characteristics of the population using e-cigarettes, specifically around JUULs and similar devices for their unique characteristics, high nicotine concentrations, and higher potential for nicotine dependence in youth, young adults and, non-smokers.

This study has several limitations. First, since this is a cross-sectional observational study, we can observe correlations, but causation cannot be drawn from the data collected. There is also the potential for the participants to change their habits after the point of data collection. Second, we employed a survey as the main method of our data collection, there is the chance for socially desirable response bias as e-cigarettes and their use could be seen in a negative context by society or portions therein. There is a potential for response bias due the recall of each participant in addition to each participants' honesty when responding to the surveys. Multiple response bias was controlled for using each participants' email address, and two responses were excluded based on matching emails. Third, this study did not measure nicotine dependence in e-cigarette users, and instead examine changes in their self-selected nicotine concentrations that current literature supports as a method of decreasing nicotine dependence. And fourth, this study measured the factors from our framework at the time of the survey to examine associations with previous change and may not accurately reflect the true associations between each construct within the framework and the self-selected nicotine change.

CHAPTER 6

CONCLUSION

Existing literature around e-cigarettes seems to support their use for harm reduction purposes. Smokers and other tobacco users seeking to use e-cigarettes for smoking cessation or harm reduction may benefit from their use in decreasing their nicotine dependence or potentially reaching cessation. However, e-cigarettes are not safe and should not be utilized by individuals who do not already use another form of nicotine. Literature on e-cigarettes and smoking cessation is inconclusive, necessitating continued vigilance in understanding the current population utilizing them and any changes within the e-cigarette marketplace. The population using e-cigarettes is constantly changing with the development of new devices like the JUUL, and similar devices, which are appealing to the young adult and adolescent population and after each legislative change at the federal or state level as well. Future studies should attempt to disseminate more information on devices like the JUUL due to their higher nicotine concentrations, appeal to young adults and adolescents, and greater potential for dependence.

CHAPTER 7

DECLERATIONS

Funding

No outside funding was utilized for this study.

Ethical Approval

This study was approved by The University of Mississippi Institutional Review Board under Protocol #18x-264.

Declaration of Interests

None declared.

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Tables

Table 1.

Descriptive Statistics of Sociodemographic Characteristics Among Survey Respondents

Sociodemographic Characteristics	n	Mean (SD)	Median	Min	Max
Age	356	23.747 (8.962)	23.5	18.0	59.0
		Frequency	Percent		
Sex					
Female		152	42.7%		
Male		203	57.0%		
Race					
Black/African American		21	5.9%		
White/Caucasian		314	88.2%		
Other		21	5.9%		
Hispanic or Latino/a					
Not Hispanic or Latino/a		349	98.3%		
Hispanic or Latino/a		6	1.7%		
Education					
High School or Less		90	25.3%		
More than High School		266	74.7%		

Table 2.

Descriptive Statistics of E-Cigarette (E-Cig) Characteristics of Use Among Survey Respondents

Vaper Characteristics of E-Cig Use	n	Mean (SD)	Median	Min	Max
E-cig Use (months)	356	23.331 (20.308)	18.0	0.0	126.0
Initial Nicotine Level (mg/ml)	356	8.851 (9.515)	6.0	0.0	59.0
Current Nicotine Level (mg/ml)	356	7.767 (11.368)	5	0.0	60.0
		Frequency	Percent		
Plans to Change Nicotine Level					
Increase		5	1.4%		
Keep Same		269	75.8%		
Decrease		81	22.8%		
Plans to Quit E-Cig					
Yes		19	5.4%		
Maybe		120	33.8%		
No		216	60.8%		
Type of E-cig Used Most					
Cig-Alike		33	9.3%		
Vape Pen		60	16.9%		
E-Hookah		2	0.6%		
Tank Mod		225	63.2%		
Drip Mod		36	10.1%		
Main Reason for E-Cig Use					
Reduce Cigarette Use		17	4.5%		
Replace Cigarette		93	26.1%		
Replace, and Reduce Nicotine Level		72	20.2%		
Quit Non-Cigarette Tobacco		18	5.1%		
Circumvent Smoking Ban		9	2.5%		
Weight Loss/Control Appetite		12	3.4%		
For Fun		61	17.1%		
For a Buzz or High		52	14.6%		
Other		22	6.2%		

Table 3.

Descriptive Statistics of Conventional Cigarette (CC) Characteristics of Use Among Survey Respondents

Vaper Characteristics of CC Use	n	Mean (SD)	Median	Min	Max
Cigarette Use (years)	316	8.005 (8.132)	5.0	0.0	40.0
Quit Attempts	309	3.201 (4.144)	2.0	0.0	25.0
		Frequency	Percent		
Cigarette Ever Use					
Yes		316	89.5%		
No		37	10.5%		
At Least One Cigarette in Last Month					
Yes		117	37.1%		
No		198	62.9%		
At Least 100 Cigarettes in Lifetime					
Yes		256	81.0%		
No		60	19.0%		
CDC Smoker					
Yes		92	29.1%		
No		224	70.9%		
Cessation Methods Used					
Any (Yes)		205	65.3%		
Nicotine Replacement Therapy (Yes)		87	27.7%		
Chantix (Yes)		40	12.7%		
Zyban (Yes)		5	1.6%		
Behavioral Therapy/ Counseling (Yes)		7	2.2%		
'Cold Turkey'/ Willpower Alone (Yes)		185	58.9%		

Table 4.

Results of Paired Samples t-Test of Current Nicotine Concentration and Initial Nicotine Concentration

Mean Nicotine Concentration		Mean Difference (SD)	95% CI of Mean Difference		p
Initial (SD)	Current (SD)		Lower	Upper	
8.851 (9.515)	7.767 (11.368)	-1.084 (11.711)	-2.305	0.136	0.082

Table 5.

Results of Linear Regression Model Examining the Associations of Respondent Sociodemographic Characteristics, E-Cigarette (E-Cig) Use Characteristics, and Conventional Cigarette Use Characteristics on Current-Initial Nicotine Concentration Change Score

Variable	Regression Coefficient (Unstandardized)				Regression Coefficient (Standardized)	p value	
	Estimate	SE	95% CI				
Constant	3.457	3.208	-2.854	9.769	-	0.282	
E-Cig Use Characteristics							
E-Cig Time (months)	-0.099	0.031	-0.159	-0.039	-0.170	0.001	
Use Most	Harm Reduction	-	-	-	-	-	
	Non-Harm Reduction	3.273	1.488	0.347	6.200	-	0.028
	Other	1.501	2.476	-3.370	6.371	-	0.545
E-Cig Most	Customizable	-	-	-	-	-	
	Non-Customizable	1.915	1.436	-0.910	4.739	-	0.183
Conventional Cigarette Use Characteristics							
CDC Current Smoker	No	-	-	-	-	-	
	Yes	2.304	1.368	-0.387	4.995	-	0.093
Cessation Any	No	-	-	-	-	-	
	Yes	-2.392	1.401	-5.148	0.363	-	0.089
Cigarette Time (years)	-0.126	0.138	-0.397	0.144	-0.086	0.360	
Sociodemographic Characteristics							
Age (years)	-0.111	0.117	-0.340	0.118	-0.086	0.342	
Sex	Female	-	-	-	-	-	
	Male	0.175	1.228	-2.241	2.591	-	0.887
Race	White/Caucasian	-	-	-	-	-	
	Black/ African American	1.356	2.513	-3.587	6.299	-	0.590
	Other	-1.978	2.432	-6.762	2.805	-	0.416
Hispanic/Latino/a	Not Hispanic/Latino/a	-	-	-	-	-	
	Hispanic/Latino/a	5.001	4.480	-3.812	13.814	-	0.265
Education	High School or Less	-	-	-	-	-	
	More than High School	0.557	1.376	-2.150	3.264	-	0.686
R ² = 0.196 ΔF = 6.133 (p<0.0001)							

Table 6.

Results of Linear Regression Model Examining the Associations of Respondent Sociodemographic Characteristics, E-Cigarette (E-Cig) Use Characteristics, Conventional Cigarette Use Characteristics, and Factors Associated with Change from Theoretical Model on Current-Initial Nicotine Concentration Change Score

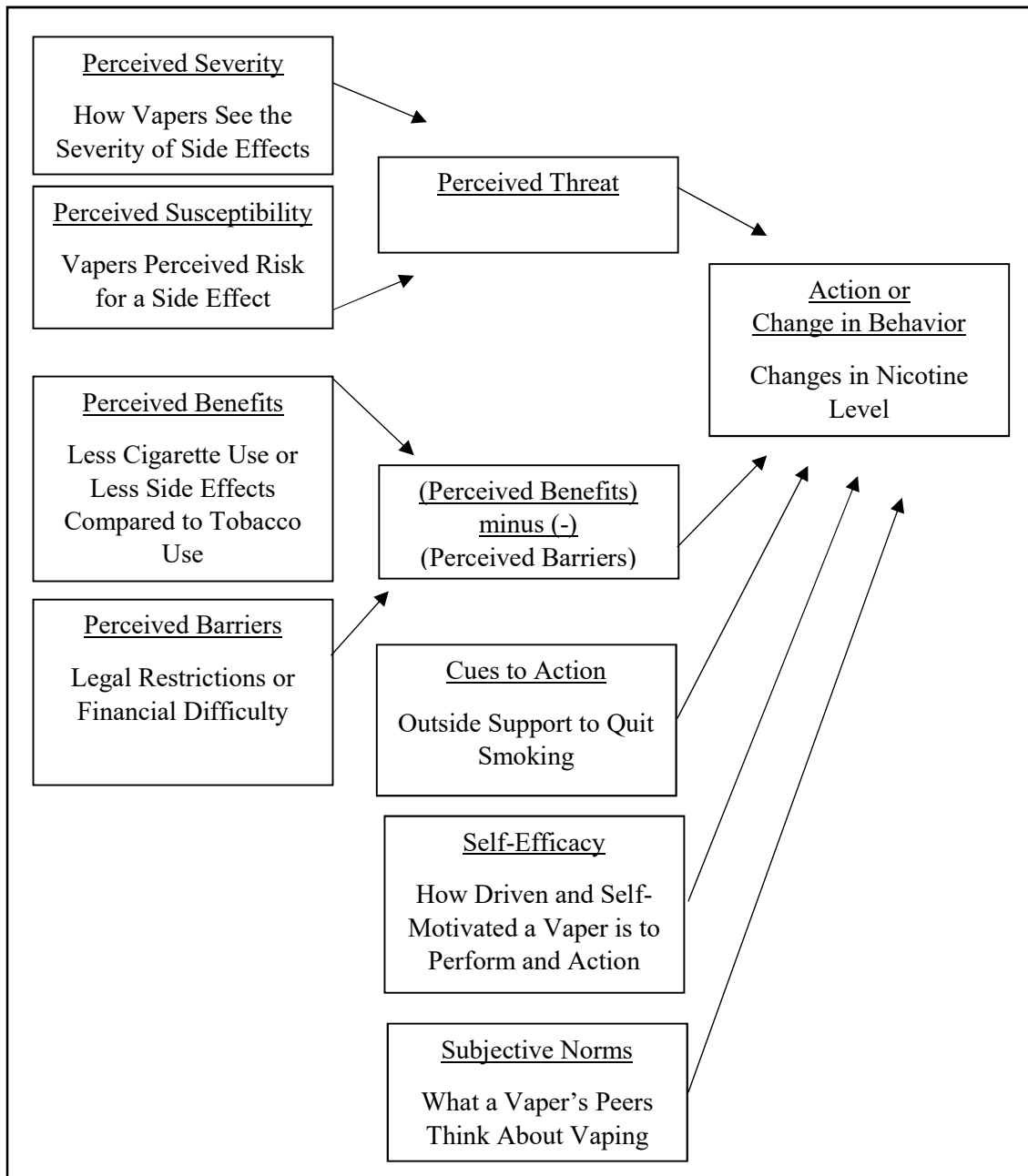
Variable	Regression Coefficient (Unstandardized)				Regression Coefficient (Standardized)	p value	
	Estimate	SE	95% CI				
Constant	6.482	10.285	-13.754	26.717	-	0.529	
E-Cig Use Characteristics							
E-Cig Time (months)	-0.095	0.031	-0.156	-0.035	-0.164	0.002	
Use Most	Harm Reduction	-	-	-	-	-	
	Non-Harm Reduction	3.087	1.501	0.134	6.040	-	0.041
	Other	2.000	2.477	-2.874	6.874	-	0.420
E-Cig Most	Customizable	-	-	-	-	-	
	Non-Customizable	1.236	1.486	-1.688	4.161	-	0.406
Conventional Cigarette Use Characteristics							
CDC Current Smoker	No	-	-	-	-	-	
	Yes	1.821	1.363	-0.861	4.503	-	0.183
Cessation Any	No	-	-	-	-	-	
	Yes	-0.098	0.139	-4.997	0.553	-	0.116
Cigarette Time (years)	-0.092	0.140	-0.372	0.177	-0.068	0.484	
Socio-Demographic Characteristics							
Age (years)	-0.108	0.119	-0.343	0.127	-0.084	0.368	
Sex	Female	-	-	-	-	-	
	Male	0.148	1.238	-2.287	2.583	-	0.905
Race	White/Caucasian	-	-	-	-	-	
	Black/ African American	1.755	2.554	-3.269	6.780	-	0.492
	Other	-1.197	2.453	-6.023	3.629	-	0.626
Hispanic/Latino/a	Non-Hispanic/Latino/a	-	-	-	-	-	
	Hispanic/Latino/a	4.571	4.473	-4.228	13.370	-	0.308
Education	High School or Less	-	-	-	-	-	
	More than High School	0.307	1.383	-2.414	3.027	-	0.825
Factors Associated with Change							
Perceived Severity	0.239	0.115	0.014	0.465	0.125	0.038	
Perceived Susceptibility	0.347	0.227	-0.099	0.793	0.103	0.127	
Perceived Benefits	0.057	0.170	-0.277	0.391	0.021	0.736	
Perceived Barriers	-0.505	0.269	-1.034	0.024	-0.104	0.061	
Cues to Action	0.025	0.225	-0.419	0.469	0.006	0.912	
Self-Efficacy	-0.340	0.139	-0.615	-0.066	-0.132	0.015	
Subjective Norms	-0.182	0.179	-0.534	0.170	-0.062	0.309	
$R^2 = 0.232$ $\Delta F = 2.176$ ($p=0.036$)							

APPENDICIES

APPENDIX A: Statements Utilized to Measure Theoretical Model of Health-Related Beliefs Regarding E-Cigarettes

Factor Associated with Change	Statements Utilized to Measure Theoretical Model of Health-Related Beliefs Regarding E-Cigarettes
Perceived Severity	I cough when using my electronic cigarette
	I get headaches when using my electronic cigarette
	My throat gets sore/dry when I use my electronic cigarette
	I am addicted to my electronic cigarette
	I can't leave my house without my electronic cigarette
	I have to use my electronic cigarette at work/school
Perceived Susceptibility	Electronic cigarettes are addictive
	I feel healthy using my electronic cigarette
	I crave using my electronic cigarette
Perceived Benefit	Electronic cigarettes are safe
	Electronic cigarettes are safer than tobacco cigarettes around my friends and family
	Electronic cigarettes are safer around my pets
	Electronic cigarettes can be used to quit smoking tobacco cigarettes
	Electronic cigarettes are safer than tobacco cigarettes
Perceived Barrier	I cough more using tobacco cigarettes than electronic cigarettes
	I am saving money with my electronic cigarette
Cues to Action	Electronic cigarettes can be used in more places than tobacco cigarettes
	My friends and family encourage me to use my electronic cigarette
	My family wants me to stop using my electronic cigarette
Self-Efficacy	My friends want me to stop using my electronic cigarette
	I am able to taper down my nicotine level over time
	I want to stop using my electronic cigarette
	I believe I can stop using my electronic cigarette
	I don't want to stop using my electronic cigarette
Subjective Norms	I believe my electronic cigarette will help me quit smoking tobacco cigarettes
	Electronic cigarettes are socially accepted
	I think my friends approve of me using my electronic cigarette
	I think my family approves of me using my electronic cigarette
	My coworkers/fellow students don't mind me using my electronic cigarette

APPENDIX B: Theoretical Framework Model ^{24,26,29,30}



APPENDIX C: Research Consent Form

Consent to Participate in Research

Study Title: Two Surveys: Questions on Electronic Cigarette History of Use, Reasons for Use, and Patterns of Use

Investigator

David D. Allen III, B.A.
Department of Pharmacy Administration
223 Faser Hall
University of Mississippi
University, MS 38677
[REDACTED]
ddallen@go.olemiss.edu

Faculty Sponsor

Yi Yang, MD, Ph.D.
Department of Pharmacy Administration
223 Faser Hall
University of Mississippi
University, MS 38677
[REDACTED]
yyang@olemiss.edu

The purpose of this study

We want to know how and why you use your electronic cigarette and to see if there are any changes in the next six (6) months.

What you will do for this study

You will be completing two surveys. One in the next few days, and one in six (6) months

1. You must be at least 18 years old to participate in this study.
2. You must currently use an electronic cigarette product to participate in this research.
3. You must have internet access, via a computer, tablet, or phone, to complete the survey.
4. Your email address will be asked for at the bottom of this consent form. Your email address will allow us to connect your answers in the first survey to your answers in the second survey.
 - a. Please provide an email you use and check on a regular basis.
5. First Survey
 - a. You will receive this survey within forty-eight (48) hours after completing this consent form.
 - b. This survey should take you about fifteen (15) to twenty (20) minutes to complete.
 - c. There are fifty-two (52) questions, and 2 information statements.
 - i. These questions will ask you about your current and past electronic cigarette and conventional (tobacco) cigarette use.
 - ii. There are five (5) questions asking for your demographic information (sex, race/ethnicity, age, and educational attainment).
 - iii. You are only required to complete nine (9) questions.
 - Qualtrics will inform you if you missed a required question and will ask you to complete it before continuing.
 - iv. While, you are only required to complete nine (9) of the fifty-two (52) questions, we encourage you to answer all the questions as this will best help out our study.

- d. The first question will contain David D. Allen III's contact information if you have any questions or issues with the survey.
 - e. At the completion of this survey, you will receive \$5.00 Amazon e-gift card in your email within ten (10) business days.
6. Second Survey (Last Survey)
- a. You will receive an email reminding you that this survey is coming up within two weeks of you receiving it.
 - b. You will receive this survey about six (6) months after completing the first survey.
 - c. This survey should take you about ten (10) to fifteen (15) minutes to complete.
 - d. This survey will contain less questions than the First Survey.
 - e. At the completion of this survey, you will receive \$5.00 Amazon e-gift card in your email within ten (10) business days.

Time required for this study

This study will take about twenty (20) minutes for the 1st survey, and fifteen (15) minutes for the 2nd survey – for a total of thirty-five (35) minutes.

Possible risks from your participation

Answering survey questions on your electronic cigarette and convention (tobacco) cigarette use may be stressful. Please see the Confidentiality section for information on how we minimize the risk of a breach of confidentiality.

Benefits from your participation

You should not expect benefits from participating in this study. However, you might experience satisfaction from contributing to the scientific knowledge on and around electronic cigarettes. Also, answering the survey questions might make you more aware of habits you'd like to change, sometimes this can help lead to improved habits.

Incentives

You will receive a one (1) \$5.00 Amazon e-gift card via email within ten (10) business days after completing each survey, for a total of two (2) Amazon e-gift cards worth a total of \$10.00.

Confidentiality

Your email address(es), phone number (where applicable), and responses will remain in password protected electronic files on a password protected laptop. Only research team members will have access to your email address(es), phone number, and responses. We will protect confidentiality by coding and then separating your email address(es), and phone number from your responses into a separate password protected document. At the end of the study, your email address(es), and phone number will be deleted along with the password protected file to further protect your identity.

Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary. We will not release

identifiable results of the study to anyone else without your written consent unless required by law.

Right to Withdraw

You do not have to volunteer for this study, and there is no penalty if you refuse. If you start the study and decide that you do not want to finish, just close your web browser. Whether or not you participate or withdraw will not affect your current or future relationship with the Department of Pharmacy Administration, or with the University, and it will not cause you to lose any benefits to which you are entitled.

The researchers may stop your participation in the study without your consent and for any reason, such as protecting your safety or protecting the integrity of the research data. If the researcher terminates your participation, any incentives will be prorated based on the amount of time you spent in the study.

IRB Approval

This study has been reviewed and approved by The University of Mississippi’s Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions or concerns regarding your rights as a research participant, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please email, or call the primary researcher, David D. Allen III, if there is anything that is not clear or if you need more information. When all your questions have been answered, you can then decide if you want to be in the study or not.

Statement of Consent

I have read the above information. I have been given an unsigned copy of this form. I have had an opportunity to ask questions, and I have received answers. I am at least 18 years old. I consent to participate in the study by providing my email address to receive the surveys.

Email Address (Please print, in the field below)

Back-up Email Address or Telephone Number (Please print, in the field below)

APPENDIX D: Survey

Electronic Cigarette History of Use, Reasons for Use, and Patterns of Use

Start of Block: E-Cigarette Survey

Q1

Please Contact David Allen if you have any questions or issues on/with the survey.

David D. Allen III



Ddallen@go.olemiss.edu



Q2

How old are you? (**years**)

Skip To: Q55 If How old are you? (years) < 18

Q3 Do you currently use any of the following: electronic cigarette, vape pen, vape pipe, vape mod, or other vape product?

Yes

No

Skip To: Q55 If Do you currently use any of the following: electronic cigarette, vape pen, vape pipe, vape mod, o... = No

Q4

What is an e-mail address we can use to reach you? Your email will also be used to compare your answers between this survey and the next survey we send you. Please remember this is also the email you will receive your Amazon e-gift card at upon completion of this survey.

Skip To: End of Survey If What is an e-mail address we can use to reach you? Your email will also be used to compare your a... Is Empty



Q5 **How long** have you used an electronic cigarette or related product? (**months**)

Q6 Are you planning to stop using your electronic cigarette in the next six (6) months?

- Yes
- Maybe
- No



Q7 **What nicotine level** e-liquid are you currently using in your electronic cigarette? (**in milligrams per milliliter, mg/ml | example: 6**)

Q8 Have you changed the nicotine level in your e-liquid since you started vaping?

- Yes
- No

Skip To: Q12 If Have you changed the nicotine level in your e-liquid since you started vaping? = No



Q9 When you first started using your electronic cigarette, **what nicotine level** e-liquid were you using in your electronic cigarette? (in milligrams per milliliter, mg/ml | example: 6)



Q10 About **how long** has it been since you last changed your e-liquid nicotine level? (months)



Q11 Before you changed your nicotine level, **what nicotine level** e-liquid were you using in your electronic cigarette? (in milligrams per milliliter, mg/ml | example: 6)

Q12 Are you planning to change the nicotine level of the e-liquid you use in the next **six (6) months**?

- Yes, increase
- No, keep the same
- Yes, decrease



Q13

Approximately, **how many milliliters (ml)** of e-liquid have you used in the past month? (**number of milliliters | ex: 120**)



Q14 On average, about **how much** do you spend on e-liquid over a month? (**dollars and cents, 00.00**)



Q15 On average, about **how much** do you spend on replacement coil, cotton, wire, or other electronic cigarette parts over a month? (**dollars and cents, 00.00 | please exclude the cost of e-liquid**)



Q16 **How many days** do you use your electronic cigarette in an average month? (**0 to 30**)



Q17

How many days did you crave using your electronic cigarette in the past month? (**0 to 30**)



Q18 On average, **how many times a day** do you puff from your electronic cigarette? (**puffs**)

Q19

What types of electronic cigarettes have you used? (please select **all** that apply)

Cig-alike (Blu, N-Joy, etc.)

Vape Pen

E-Pipe

E-Hookah

Vape Mod with a Tank Atomizer

Vape Mod with a Drip Atomizer

Q20

Thinking about the list above, which type of electronic cigarette have you used the **most**? (please select **only one**)

- Cig-alike (Blu, N-Joy, etc.)
 - Vape Pen
 - E-Pipe
 - E-Hookah
 - Vape Mod with a Tank Atomizer
 - Vape Mod with a Drip Atomizer
-

Q21 Which of the following reasons describe why you are using your electronic cigarette. (please select **all** that apply)

- To avoid tobacco withdrawal symptoms, by using my electronic cigarette in areas where I am not allowed to smoke tobacco cigarettes
 - To quit smoking tobacco cigarettes, by reducing how many tobacco cigarettes I smoke
 - To quit smoking tobacco cigarettes, by replacing tobacco cigarettes with my electronic cigarette
 - To quit smoking tobacco cigarettes, by replacing tobacco cigarettes with my electronic cigarette and changing my nicotine level
 - To quit another form of tobacco
 - To control my appetite or for weight loss
 - I use my electronic cigarette for fun
 - I use my electronic cigarette for the buzz that nicotine gives me
 - Other, not listed here
-

Q22 Thinking about the previous question, which reason do you feel **most closely** describes why you use your electronic cigarette. (please select **only one**)

- To avoid tobacco withdrawal symptoms, by using my electronic cigarette in areas where I am not allowed to smoke tobacco cigarettes
- To quit smoking tobacco cigarettes, by reducing how many tobacco cigarettes I smoke
- To quit smoking tobacco cigarettes, by replacing tobacco cigarettes with my electronic cigarette
- To quit smoking tobacco cigarettes, by replacing tobacco cigarettes with my electronic cigarette and changing my nicotine level
- To quit another form of tobacco
- To control my appetite or for weight loss
- I use my electronic cigarette for fun
- I use my electronic cigarette for the buzz that nicotine gives me
- Other, not listed here

Display This Question:

If Thinking about the previous question, which reason do you feel most closely describes why you use... = Other, not listed here

Or Which of the following reasons describe why you are using your electronic cigarette. (please sele... = Other, not listed here

Q23 You have selected **other** in one of the previous questions, please explain the reason why you use your electronic cigarette.



Q24 Which of the following types of flavors do you use for your e-liquid? (please select **all** that apply)

- Tobacco
 - Menthol
 - Fruit
 - Dessert
 - Candy
 - Beverage
 - Other
-



Q25 Thinking about the above, which of the following types of flavors do you use **most often** for your e-liquid?

- Tobacco
 - Menthol
 - Fruit
 - Dessert
 - Candy
 - Beverage
 - Other
-

Display This Question:

If Which of the following types of flavors do you use for your e-liquid? (please select all that apply) = Other
Or Thinking about the above, which of the following types of flavors do you use most often for your... = Other

Q26 You have selected **other** in one of the previous questions, please describe the flavor.

Q27 Have any of your friends or family members **ever** used an electronic cigarette? Please select one option for each of the following.

	Yes	No	Uncertain/ Don't Know
Immediate Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Close Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skip To: Q30 If Have any of your friends or family members ever used an electronic cigarette? Please select one o...
= Immediate Family

Q28 Do any of your friends or family members **currently** use electronic cigarettes? Please select one option for each of the following.

	Yes	No	Uncertain/ Don't Know
Immediate Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Close Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q29 Have any of your friends or family members **ever** used their electronic cigarette to help them quit smoking tobacco cigarettes? Please select one option for each of the following.

	Yes	No	Uncertain/ Don't Know
Immediate Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Close Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q30

What is your sex.

Female

Male

Q31

Are you Hispanic or Latino?

No

Yes, I am Hispanic or Latino/Latina

Q32 What race or races do you consider yourself to be? (please select at least one, or all that apply)

American Indian or Alaska Native

Asian

Black or African American

Native Hawaiian or other Pacific Islander

White or Caucasian

Q33

Please select the **highest** level of education you have completed.

- Less than high school
 - High school graduate
 - Some college
 - 2-year degree (ex. Associate's degree)
 - 4-year degree (ex: Bachelor's degree)
 - Professional degree
 - Master's degree
 - Doctoral degree
-

Q34 Have any of your friends or family members **ever** smoked tobacco cigarettes? Please select one option for each of the following.

	Yes	No	Uncertain/ Don't Know
Immediate Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Close Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skip To: Q36 If Have any of your friends or family members ever smoked tobacco cigarettes? Please select one opt... = Immediate Family

Q35 Do any of your friends or family members **currently** smoke tobacco cigarettes? Please select one option for each of the following.

	Yes	No	Uncertain/ Don't Know
Immediate Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Close Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Friends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q36 Have you **ever** smoked tobacco cigarettes?

Yes

No

Skip To: Q48 If Have you ever smoked tobacco cigarettes? = No

Q37 Have you smoked at least **one (1)** tobacco cigarette in the last month?

Yes

No

Q38 Have you smoked at least **100** tobacco cigarettes (**5 packs**) in your lifetime?

- Yes
- No



Q39 **How many years** have you smoked tobacco cigarettes over your life? (**years**)



Q40 On average, **how much** do/did you spend on tobacco cigarettes over a month? (**dollars and cents: 00.00**)

Q41 Do you **now** smoke tobacco cigarettes everyday, some days, or never?

- Everyday
- Some days
- Never

Skip To: Q44 If Do you now smoke tobacco cigarettes everyday, some days, or never? = Everyday



Q42 When you smoked, **how many** tobacco cigarettes did you smoke in a day on average? (**cigarettes**)



Q43 **How many months** has it been since you quit smoking tobacco cigarettes? (**months**)

Skip To: Q46 If How many months has it been since you quit smoking tobacco cigarettes? (months) Is Not Empty



Q44 On average, **how many** tobacco cigarettes do you smoke each day? (**cigarettes**)

Q45 Are you trying to reduce how often you smoke tobacco cigarettes?

Yes

No



Q46 In the past, about **how many** times have you tried to quit smoking tobacco cigarettes? (**number of attempts**)

Q47

Have you tried using any of the following methods to quit smoking tobacco cigarettes? (please select all that apply)

- Nicotine Replacement Therapy (nicotine gum nicotine patches, or nicotine lozenges)
 - Chantix (varenicline tartrate)
 - Zyban (bupropion hydrochloride)
 - Cold turkey/ Willpower alone
 - Counseling/ Behavioral therapy
 - None of these
-



Q48 Please identify your level of agreement for each of the following statements. (Strongly agree to Strongly disagree)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Electronic cigarettes can be used to quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes are safer than tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes are safe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes are addictive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes are socially accepted	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes are safer than tobacco cigarettes around my friends and family	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes are safer around my pets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q49 Please identify your level of agreement for each of the following statements. (Strongly agree to Strongly disagree)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
I can tell when I need to add more e-liquid to my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel healthy using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I cough when using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I cough more using tobacco cigarettes than electronic cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get headaches when using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My throat gets sore/dry when I use my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to taper down my nicotine level over time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q50 Please identify your level of agreement for each of the following statements. (Strongly agree to Strongly disagree)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
I am saving money with my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to stop using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe I can quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe I can stop using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe my electronic cigarette will help me quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q51 Please identify your level of agreement for each of the following statements. (Strongly agree to Strongly disagree)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
I crave using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I crave smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't want to stop using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't want to quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am addicted to my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can't leave my house without my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have to use my electronic cigarette at work/school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic cigarettes can be used in more places than tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q52 Please identify your level of agreement for each of the following statements. (Strongly agree to Strongly disagree)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
My family wants me to quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My family is supportive of me quitting tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My friends want me to quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My friends are supportive of me quitting tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E-liquid flavors help me to quit smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E-liquid flavors help me to not crave smoking tobacco cigarettes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Q53 Please identify your level of agreement for each of the following statements. (Strongly agree to Strongly disagree)

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
My friends and family encourage me to use my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My family wants me to stop using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My friends want me to stop using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My coworkers/fellow students don't mind me using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think my friends approve of me using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think my family approves of me using my electronic cigarette	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q54

Thank you for completing this survey. Your participation is greatly appreciated.
Your Amazon e-gift card will be emailed to you within the next 10 business days.
Please note that you will receive the next survey via email in 6 months.

Display This Question:

If Thank you for completing this survey. Your participation is greatly appreciated. Your Amazon e-gi... Is Not Displayed

Q55 Thank you for your time but you have not qualified to complete this survey.

End of Block: E-Cigarette Survey

VITA

Born in 1992, David D. Allen III has had a wide variety of experiences during his upbringing. While born in Kentucky, he was raised primarily in the Panhandle of Texas and northeast Ohio. David has been exposed to a plethora of lifestyles in different settings throughout his lifetime, seeing the ups and downs of individual and societal issues. This Thesis focused on something close to his passion, to enable individuals to reach nicotine cessation through their own means and hopefully prevent the known adverse events associated with tobacco use.

David completed his Bachelor's in Political Science at the University of North Texas in Denton, Texas. After a break year, he began the pursuit of his Master's and PhD in Pharmaceutical Sciences with an emphasis in Pharmacy Administration. His experiences in healthcare policy, public health, and pharmacoeconomics enabled him to bring this Master's Thesis to light under the guidance of a body of supportive faculty members and fellow student colleagues.

David has been associated with a small amount of publications at this time but aims to grow his peer-reviewed repertoire after the dissemination of this Thesis publication. He maintains his interest in research looking at potentially harm reducing strategies to aid in the cessation of various substances, including nicotine. In doing so, he hopes to further this research moving forward into the development, enactment, and future dissemination of his Doctoral Dissertation.