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# Behavioral, Environmental, Social, Psychosocial, and Physiological Factors That Impact the Relationship Between Chronic Lung Disease Status and Susceptibility to Electronic Cigarette Use or Actual Electronic Cigarette Use

Mohammed M. Alqahtani
*University Of Alabama At Birmingham*

# BEHAVIORAL, ENVIRONMENTAL, SOCIAL, PSYCHOSOCIAL, AND PHYSIOLOGICAL FACTORS THAT IMPACT THE RELATIONSHIP BETWEEN CHRONIC LUNG DISEASE STATUS AND SUSCEPTIBILITY TO ELECTRONIC CIGARETTE USE OR ACTUAL ELECTRONIC CIGARETTE USE

by

MOHAMMED M. ALQAHTANI

PETER HENDRICKS, COMMITTEE CHAIR
MARK DRANSFIELD
PAVELA GREG
DONALD H. LEIN JR
MICHAEL WELLS

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FACTORS THAT IMPACT THE RELATIONSHIP BETWEEN CHRONIC LUNG DISEASE STATUS AND SUSCEPTIBILITY TO ELECTRONIC CIGARETTE USE OR ACTUAL ELECTRONIC CIGARETTE USE

MOHAMMED M. ALQAHTANI

REHABILITATION SCIENCE

## ABSTRACT

There is surge increase in e-cigarettes among adult vulnerable population such as individuals with chronic lung disease (CLD). Currently, there is a lack of understanding of the factors that may lead to the increase use of e-cigarettes or susceptibility of e-cigarette use among individuals who have a history of CLD. Thus, it is crucial to recognize the characteristics of the individuals with CLD and adults without CLD who are susceptible to using e-cigarettes because this may pave the way for the prevention and reduction of tobacco use by identifying the different factors and eventually targeting the related risk factors. In this dissertation, we assessed the characteristics of individuals with and without CLD who are susceptible to using e-cigarette or actual e-cigarette use and the influence of different factors. This dissertation is reported in three different papers. In the first paper, we sought to assess the association between CLD, and e-cigarette use and to decide whether binge drinking moderates this relationship. E-cigarette use appears to be more common among adults with self-reported CLD. We also found that binge drinking was positively associated with e-cigarette use, however, more numerous binge drinking episodes undermined the link between CLD and e-cigarette use. In the second paper, we

assessed whether mental health condition explains the association between CLD and e-cigarette use, and whether the association between CLD and e-cigarette use is conditional on the presence or absence of respiratory symptoms. The association between CLD and e-cigarette use may be due, in part, to poorer mental health among individuals with CLD. our analyses did not indicate a statistically significant interaction between chronic lung disease and respiratory symptoms in the likelihood of e-cigarette use. These findings provide preliminary evidence that improving the mental health of individuals with CLD could reduce e-cigarette use in this population. In the third paper, we looked at the association between clinical diagnosis CLD status and the susceptibility of e-cigarette and, to see if behavioral or environmental factors influence this relationship. We found out that the susceptibility to using e-cigarettes was higher among adults without CLD than those with. Warning label, receiving discounts or coupons, drinking was associated with an increased likelihood of susceptibility to using e-cigarettes independent of CLD status. However, our analyses did not indicate a statistically significant interaction between CLD and any of the environmental or behavioral factors in the susceptibility of using e-cigarette use. Longitudinal investigations are demanded to better evaluate the sequential relationship between CLD, substance use, environmental factors, and the susceptibility to using e-cigarettes among individuals with CLD to prevent further lung damage.

Keywords: Electronic cigarette, Chronic Lung Disease, Mental Health, Substance Use, Behavioral Factors, Psychosocial Factors, Environmental Factor, and Physiological Factor

# DEDICATION

*I want to dedicate this dissertation to the soul of my mother and to my father, who passed away while I was pursuing this degree. Without their support and prayers, I could not have achieved this distinction. Their morals, encouragement, persistence, patience, and all the good things they taught me during my childhood helped me reach my potential and overcome obstacles in my life*

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| 95% CI | 95% Confidence interval |
| A.A. | Associate in Arts degree |
| A.S. | Associate in Science |
| B. A | Bachelor of Arts |
| B. S | Bachelor of Science |
| BRFSS | Behavioral Risk Factor Surveillance System |
| B | Beta coefficients |
| CDC | Centers for Disease Control and Prevention |
| COPD | Chronic obstructive pulmonary disease |
| E-cigarettes | Electronic cigarettes |
| FDA | Food and Drug Administration |
| ICD-10 | International Classification of Diseases, Tenth Revision |
| J.D. | Juris Doctor |
| M.A | Master of Arts |
| M.D | Doctor of Medicine |
| M.S | Master of Science |
| OR | Odds ratios |
| Ph.D. | Doctor of Philosophy |
| SE | Standard errors |
| SHV | Secondhand vaping |
| UAB | University of Alabama at Birmingham |
| WHO | World Health Organization |

# INTRODUCTION

Tobacco smoking is considered one of the greatest health-related problems of the 21st century [1]. Smoking tobacco is a risk factor for morbidity and mortality. The use of tobacco products increases the risk of multiple chronic lung diseases, such as asthma, chronic obstructive pulmonary disease (COPD), as well as tuberculosis and lung cancer [2]. Tobacco smoking can exacerbate existing chronic lung diseases [3]. Among those with COPD, smokers have a higher decline in lung function than non-smokers [4]. Smoking increases the risk of asthma exacerbation, wheezing, and co-morbid lower respiratory infections [5]. Finally, the World Health Organization (WHO), estimated six million people die every year as a result of tobacco-related diseases [6], and overall, it has caused an estimated 100 million deaths, which is more than the number of fatalities during World Wars I and II combined [1].

Recently, manufacturers introduced e-cigarettes, which provide users an experience that mimics tobacco smoking [7-9]. Hon Lik, a Chinese pharmacist, created e-cigarettes in the year 2000 [10], and they were introduced for retail sale in 2004 as a less dangerous substitute for conventional cigarettes [8, 11]. Today there are a variety of e-cigarette devices available, each with its own set of flavored solutions. Flavored solutions can be purchased separately and concentrations of nicotine ranging from 0 mg/mL to 36 mg/mL. The solutions primarily consist of carrier combinations, usually propylene glycol, with or without glycerol [8-10, 12, 13].

Despite the claim that e-cigarettes are less dangerous than tobacco cigarettes, there is robust evidence that e-cigarettes contain chemical compounds that may lead to negative health consequences [8, 14]. A study conducted in the United Kingdom, for example, showed that nitrosamines and their metabolites, including carcinogenic metabolites, have been quantified in the urine of e-cigarette users [15]. Additional researchers evaluated the level of toxic carbonyl compounds and carcinogens in e-cigarette vapors and determined that the vapors contained poisonous combinations of formaldehyde, acetaldehyde, acrolein, propanol, acetone, and butanal [9, 16]. Further, the users in their study had higher levels of metabolites of acrylonitrile, acrolein, propylene oxide, acrylamide, and crotonaldehyde in their urine [14, 17]. In another study that evaluated the carcinogenic compounds linked to bladder cancer, Fuller, et al. [18] revealed that the presence of two carcinogens —o-toluidine and 2-naphthylamine ($p = .0013$, $p = .014$, respectively)—were higher in the urine samples of e-cigarette users than in those of non-e-cigarette-using control subjects [18]. The aerosols emitted from e-cigarettes contain a high level of carbonyls, which carry cardiovascular risk toxicity [8]. Additionally, the nicotine that is used in e-cigarettes is a sympathomimetic drug that can stimulate changes in hemodynamic metabolic parameters, and eventually these changes may cause acute cardiac episodes such as arrhythmia or plaque rupture dyslipidemia [19].

Even more concerning e-cigarettes can lead to long-term cardiovascular and pulmonary consequences, like those that result from conventional cigarette use [8, 9, 20]. Studies have found that e-cigarettes yield chronic lung inflammation, mucus hypersecretions, neutrophil inflammation, a loss in host defense, a reduction in gas exchange, and lung tissue damage mediated by protease [11, 21]. Further, one can develop

COPD from inhaling acrolein, which is a product of heating some components of e-liquids, such as propylene glycerol and glycerin [22]. Recently, the outbreak of lung injuries and mortalities linked with e-cigarette use has attracted public attention to e-cigarette use or vaping and underlined how little investigators still know concerning the effects and control of e-cigarette use [23, 24].

Research also shows that e-cigarettes adversely affect lung physiology and increase respiratory symptoms among individuals with asthma and COPD. E-cigarettes can result in throat irritation, coughing, and an increase in airway resistance [8, 25]. Overall, a diagnosis of asthma has been highly associated with e-cigarette use (OR = 2.74; 95% confidence interval [21, 26]. In summary, e-cigarette users are exposed to high quantities of ultrafine particles and chemicals, which can raise the risk of developing several cardiopulmonary disorders [8, 11].

Researchers are currently divided regarding whether e-cigarettes should be used as an aid for smoking cessation. Some recent studies have shown no correlation between e-cigarette use and smoking cessation, while other studies have provided mixed results regarding e-cigarette effectiveness in terms of smoking cessation [27]. According to one study224 (18%) of 1,242 smokers, stated that smoking cessation occurred after using nicotine-enriched e-cigarettes for a minimum period of 6 months [28].

In contrast, e-cigarettes have been viewed as a gateway to cigarette smoking, with one study showing that over a 2-year period, approximately 180,000 “never smokers,” and 45,000 current smokers in the United States may have started smoking combustible cigarettes after initiating e-cigarette use [29]. Additional studies have displayed that those who use e-cigarettes continued to smoke regular cigarettes as well [11]. For example, in the

United States, one study revealed that 93% of e-cigarette users also smoked conventional cigarettes, whereas in France, 83% of e-cigarette users continued to use conventional cigarettes [30, 31]. Overall, meta-analyses showed that current cigarette smokers who had used e-cigarettes were more likely to *intend* to quit smoking but were less likely to actually stop smoking [32].

Despite the negative side effects of e-cigarettes, their use is starting to be pervasive worldwide among the adult population. In Europe, for example, data from 28 EU member-states exhibited that since 2014 the proportion of those who have at least tried e-cigarettes has increased (12% in 2014 vs. 15% in 2017) [25]. There was also a dramatic increase in e-cigarette use among the US population [33]. One study which involved 3,000 adults, indicated that both earlier and current use of e-cigarettes increased—from 1.8% to 13.0% (earlier use) and from 0.3% to 6.8% (current use), between 2010 and 2013 [25]. Previous research has shown that e-cigarette use was common among all age groups, whether they had a history of smoking or not, with the percentage of adults who had ever tried an e-cigarette in their lifetime as follows: 18–24 years (5.3%), 25–34 years (3.6%), 35–44 years (2.3%), 45–55 (1.7%), 55-64 (1.5%), and 65 years and over (0.6%) [34]. E-cigarette use was not limited to those who had used tobacco but was also prevalent among adults who had never been cigarette smokers. Of these, 1.2%, approximately 29.3 million adults, stated they had tried e-cigarettes [25].

Vaping has also been shown to be prevalent, and even increasing, among vulnerable populations, including individuals with chronic lung disease [35-37]. For example, in a study examining the absolute difference in age-adjusted prevalence of current e-cigarette use among individuals with a history of chronic lung diseases against

those without, the prevalence of disease was 7.1% (CI, 6.2–8.0%) higher in those with COPD, and 1.9% (CI, 1.4–2.4%) higher in those with asthma than in those without chronic lung [36]. At present, the mechanism (s) leading to e-cigarette use in anyone, or the susceptibility to e-cigarette use specifically among individuals with a history of chronic lung disease has not been thoroughly studied.

Like tobacco smoking, many factors may lead to susceptibility to or actual e-cigarette use including psychosocial, environmental, social, behavioral, physiological, and health beliefs. Psychosocial difficulties, such as depression and anxiety, have been linked to developing or maintaining a smoking habit, while depressed or anxious individuals are more likely than the average person to start smoking at a younger age, smoke more heavily, and become addicted to cigarettes [38, 39]. Some research has supported smoking as "self-medication;" that people with mental health issues (i.e., negative affectivity) utilize drugs like nicotine to cope with or reduce some of their psychological symptoms [40].

Mental health issues are widespread among those with chronic lung disorders, according to a growing body of research. According to some research, COPD patients are 10 times more prone than the general population to have anxiety and sadness; specifically, panic disorder or panic attacks [41, 42]. Furthermore, anxiety and depression have been reported to be prevalent among individuals with asthma [42, 43]. Thus, mental illness may be the intermediate mechanism that links chronic lung disease to susceptibility to and/or use of e-cigarettes. However, this has not been established, and further research is needed to examine this, as well, as other possibilities.

The e-cigarette industry first started marketing e-cigarettes as an apparently healthy alternative to cigarette smoking [8, 44]. Today, there are 48 countries that control e-cigarette marketing. Even though e-cigarette advertising is not restricted in the United States, in 2016, the US Food and Drug Administration established new regulations on all tobacco products, including e-cigarettes. There are now health warnings on all tobacco products and e-cigarette advertisements, but they do not impose any restriction on e-cigarette marketing beyond warning labels [45]. Of note, a study revealed that increased exposure to tobacco marketing resulted in a significantly greater belief that e-cigarettes lacked nicotine and are less addictive than conventional cigarettes. In addition, the advertising of e-cigarettes was associated with increased susceptibility to future e-cigarette use, especially among those who received coupons [46]. Other evidence has demonstrated the impact of social factors such as friends or family members' use of e-cigarettes or e sources of e-cig information such as doctors on e-cigarette use and initiation [47]. Currently, it is unclear how these environmental or social factors might differentially influence the susceptibility to using e-cigarettes between chronic lung diseased individuals and individuals without chronic lung disease.

There is a lack of knowledge on modifiable health behaviors that may promote (or decrease) e-cigarette usage among people with chronic lung disease. In the United States, alcohol and tobacco use are the leading causes of unnecessary deaths in adolescent and many adult age groups [48]. Alcohol and tobacco are frequently used together [49]. Indeed, people who are dependent on alcohol are three times more likely to smoke than the general population [49]. Furthermore, a recent study found that binge drinking is linked to the usage of e-cigarette [50]. Further, marijuana use increases the probability of later or

concurrent cigarette smoking [51]. Moreover, there is a recent study that showed that cannabis use is associated with heavier present e-cigarette use in adult population [52]. Despite the noted studies on the relationship of alcohol and concomitant smoking of tobacco or e-cigarettes, the effect of alcohol or cannabis abuse on the association between chronic lung diseases and e-cigarette use is not yet well understood.

It has been reported that people with chronic lung disease are more likely to use e-cigarettes [37, 53] for several reasons, including smoking cessation, cigarette reduction, and harm reduction [35]. In addition, people with lung disease may vape to avoid or to escape the negative effect of a chronic condition [54], such as poor respiratory function and symptoms. Despite this, it is unclear that people with chronic lung disease may use an e-cigarette to mitigate or avoid the negative effect of chronic lung disease and how they differ from those without this disease.

More research is required to better understand e-cigarette use patterns and to understand the determinants of e-cigarette use by adults, and how they might be curbed with consideration of their addictiveness and sensory attractiveness [55]. Smoking behavior as regards tobacco is complex, which is what drives researchers to understand the factors associated with smoking initiation [56]. It is acknowledged that understanding the susceptibility to smoking is one of the essential steps to curbing tobacco use in the future [57]. It has been also demonstrated that susceptibility to using an e-cigarette is referred to an existing intention to use an e-cigarette in the future; susceptibility reflects an increased likelihood of tobacco experimentation [58]. Moreover, it is exhibited that susceptibility to using e-cigarettes reflects actual e-cigarette use; several studies have demonstrated that

susceptibility to e-cigarette use is an independent predictor of future initiation and past 30-day use of an e-cigarette [59, 60].

While associations between health behavior such as e-cigarette use and potential factors that may lead to e-cigarette use are helpful more understanding of these relationships can be derived from moderation and mediation analyses. These analyses allow researchers to understand the "how," "when," "for whom," "which," and "under what conditions," since "third" variables that can demonstrate how two different variables may be related [61].

In 1986, Baron and Kenny introduced various concepts and strategies to discern and define the differences between mediation and moderation. The moderation variable was considered as one as a moderator of the relationship between the independent variable (T) and the dependent variable (O) in a specific population only if it illustrates under what conditions T is related to O. In contrast, a mediator demonstrates how or why T is linked to O [62]. Limited studies have examined the potential factors that may increase susceptibility to e-cigarette use among adults with chronic lung disease. In the present study, knowledge should be expanded regarding the relationship between chronic lung disease status and susceptibility to e-cigarettes or actual e-cigarette use by studying some potential moderating and mediating variables.

Presently, there is an incomplete understanding of the factors responsible for e-cigarette use among individuals with chronic lung disease. Therefore, it is necessary to study various factors to deepen our understanding of and obtain more complete information about why e-cigarette use is common among individuals with chronic lung disease. For this reason, the present research project explored various potential

behavioral, physiological, social, psychosocial, and environmental factors that might affect the association between chronic lung disease status and susceptibility to or the use of e-cigarettes.

The aims of this research project include:

**Specific Aim 1:** To examine e-cigarette use in adults aged 18 years or older with a history of chronic lung disease using nationally representative data (The Behavioral Risk Factor Surveillance System, 2018). We hypothesized that such individuals will have a higher prevalence of e-cigarette use. We also assessed the following hypotheses: Behavioral variables (binge drinking) moderate the relationship between chronic lung disease status (chronic lung disease vs. non- chronic lung disease groups) and e-cigarette use.

**Specific Aim 2:** To examine psychosocial factor as mediators of the relationship between chronic lung disease status e-cigarettes. We tested the following hypothesis: Whether poorer mental health conditions mediate the relationship between chronic lung disease status and e-cigarettes.

**Specific Aim 3:** To examine behavioral, social and environmental factors as moderators of the relationship between chronic lung disease status and susceptibility to using e-cigarettes. The following hypothesis were evaluated: behavioral factors (alcohol use, cannabis use), social factors (using e-cigarettes at home, and exposure to second hand vaping) and environmental factors (exposure to e-cigarette advertising, exposure to

warning labels e-cigarette devices/packaging, receipt of e-cigarette coupons) moderate the relationship between chronic lung disease status and susceptibility to using e-cigarettes. We explored this hypothesis by administering a battery of questionnaires to assess individuals with chronic lung disease as well as adults without chronic lung disease.

# BINGE DRINKING MODERATES THE ASSOCIATION BETWEEN CHRONIC LUNG DISEASE AND E-CIGARETTE USE

by

MOHAMMED M. ALQAHTANI, ABDULLAH M. M. ALANAZI, GREGORY PAVELA, MARK T. DRANSFIELD, J. MICHAEL WELLS, DONALD H. LEIN JR, PETER S. HENDRICKS

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Format adapted for dissertation

# ABSTRACT

## Introduction

There is a paucity of research on e-cigarette use among adults with chronic lung disease. Accordingly, little is known about the factors that may contribute to e-cigarette use in this population. The purpose of this study was to evaluate the relationship between chronic lung disease and e-cigarette use and to determine whether binge drinking moderates this relationship.

## Methods

Data were derived from the 2018 Behavioral Risk Factor Surveillance System (BRFSS). Logistic regression was used to test the association between chronic lung disease status and e-cigarette use, controlling for demographic variables and chronic health conditions. We conducted moderation analyses to test the hypothesis that the association between chronic lung disease and lifetime e-cigarette use would be modified by binge drinking.

## Results

The prevalence of lifetime e-cigarette use was higher among adults with chronic lung disease than among those without, and more frequent binge drinking was associated with an increased likelihood of lifetime e-cigarette use independent of chronic lung disease status. Binge drinking moderated the relationship between chronic lung disease and lifetime use of e-cigarettes such that the association between chronic lung disease

and e-cigarette use was weaker among those who engaged in more episodes of binge drinking in the past 30 days. Among those without chronic lung disease, binge drinking was associated with an increased likelihood of e-cigarette use.

## Conclusion

E-cigarette use appears to be more common among adults with chronic lung disease. Although binge drinking was positively associated with e-cigarette use, more frequent binge drinking weakened the relationship between chronic lung disease and e-cigarette use. Though future studies are needed to determine precisely how binge drinking affects this association, it is possible that individuals with chronic lung disease who binge drink more frequently use e-cigarettes less frequently, despite an increased likelihood of having ever used an e-cigarette.

**Key words:** Asthma, COPD, Chronic lung disease, e-cigarette, alcohol

Quick Look

Current knowledge

There is limited research on a) the relationship between chronic lung disease and e-cigarette use, and b) whether other health behaviors, including binge drinking, moderates this relationship.

What this paper contributes to our knowledge

This is the first investigation to show that binge drinking moderates the association between chronic lung disease and e-cigarette use. Though somewhat counterintuitive, we found that the association between chronic lung disease and e-cigarette use was weaker among more frequent binge drinkers. This finding might reflect the impact of binge drinking on pulmonary function and concerns about the compounding effects of e-cigarette use. This finding may suggest that healthcare providers should not only screen for e-cigarette use but also binge drinking when treating patients with chronic lung disease due to the deleterious effects of excessive alcohol intake on pulmonary health.

# INTRODUCTION

Chronic lung disease such as chronic obstructive pulmonary disease (COPD) and asthma significantly diminish the health and well-being of affected individuals[1] and together constitute the fourth leading cause of death in the United States.[2] Smoking is a leading cause of COPD and is known to increase the risk of asthma development.[1, 3] Moreover, smoking negatively affects pulmonary function and increases the frequency of respiratory exacerbation among adults with chronic lung disease.[4] [5] Smoking, therefore, is strongly discouraged in individuals with chronic lung disease.[6]

Recently, several forms of alternative tobacco products have become available. Notable among these are electronic cigarettes (e-cigarettes), which deliver nicotine by vaporizing nicotine-containing fluid.[7] First retailing in 2004, e-cigarettes were initially marketed as less dangerous substitutes for conventional combustible tobacco cigarettes.[8]

E-cigarette use is prevalent among adults who have never smoked combustible cigarettes and may serve as a gateway to combustible cigarette smoking.[9] Some studies have reported that e-cigarette users continue to smoke combustible cigarettes as well, and meta-analyses support this finding [8]. Furthermore, e-cigarette use is prevalent among vulnerable populations, including individuals with chronic lung disease.[10] In a recent study among adults in the United States, the age-adjusted prevalence of e-cigarette use was an estimated 7.1% higher in those with COPD and 1.9% higher in those with asthma than in those with no history of chronic lung disease.[11] This may be because individuals with smoking-related chronic lung disease perceive e-cigarettes to be a safer alternative to combustible cigarettes. [10] Indeed, smokers with COPD or asthma report using e-

cigarettes to quit or reduce combustible cigarette consumption or to reduce the harm from smoking.[12, 13]

There is, however, evidence that e-cigarettes have detrimental side effects. For instance, e-cigarette vapor contains poisonous combinations of formaldehyde, acetaldehyde, acrolein, propanol, acetone, and butanal.[14] Acrolein, a product found in cigarette smoke and e-cigarette liquid as well as e-cigarette vapor,[8] reduces host defense responses and induces lung inflammation, mucus hypersecretion, neutrophil inflammation, and protease-mediated lung tissue damage.[8] Moreover, e-cigarettes adversely affect airway physiology and respiratory symptoms among patients with chronic lung disease such as asthma and COPD, causing throat irritation, cough, and increased airway resistance.[9]

Modifiable health behaviors that may affect e-cigarette use among those with chronic lung disease are poorly understood. One important health behavior is alcohol consumption.[15] Alcohol use is the second leading cause of preventable death in the United States behind smoking.[16] Alcohol and tobacco are often used together, and those dependent on alcohol are three times more likely to smoke than those in the general population are.[17]

Binge drinking can place a heavy burden on society and is considered to be the most common, costly, and deadly pattern of excessive alcohol consumption, contributing to over half of the deaths and three fourths of the economic costs incurred by excessive drinking.[18, 19] The positive association between binge drinking and combustible cigarette use has been well documented, [20] and mirroring these findings, recent results have demonstrated the positive relationship between binge drinking and e-cigarette use among

adults in the United States.[21] Notably, substantial evidence suggests that binge drinking negatively affects lung health, with independent additive negative effects on lung function in smokers.[22]

Given the relationship between binge drinking and e-cigarette use,[21] it is important to know whether a similar relationship exists among people with chronic lung disease. Importantly, scientific evaluation of the relationship between binge drinking and e-cigarette use among people with chronic lung disease may suggest methods to prevent e-cigarette use, and thus prevent further lung damage, among these individuals. The aims of this study were to: (1) evaluate the association between chronic lung disease and e-cigarette use; and (2) determine whether this association is moderated by binge drinking. We hypothesized that the association between e-cigarette use and chronic lung disease would be stronger among those who reported more frequent binge drinking.

## METHODS

### Design and Data Sources

Data from adult participants were obtained from the cross-sectional Behavioral Risk Factor Surveillance System (BRFSS, 2018),[23] the nation's foremost system of health-related telephone surveys that collects self-reported data from U.S. residents aged 18 and over regarding their health-related risk behaviors, chronic health conditions, and preventive services use. Landline telephone numbers were randomly selected using a disproportionate stratified sample design, and data were collected from a randomly selected adult in a household. Cellular telephone numbers were also randomly selected

using cellular telephone sampling frames, and data were collected from an adult who answered the cellular telephone if he or she resided in a private residence or college housing. The full description of sampling and questionnaire methodology can be found on the BRFSS website (https://www.cdc.gov/brfss/annual_data/annual_2018.html).[24] The protocol and model used in this study were registered with ClinicalTrials.gov (NCT04135404) before data analyses were performed.

### Weighting Process

Data were collected in 2018 in 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands via landline or cellular telephone calls. The CDC uses raking methodology to weight BRFSS data; this methodology allows the incorporation of landline and cellular telephone survey data and the introduction of additional characteristics that enhance the degree to which the BRFSS sample represents the make-up of the U.S. population. More details on the weighting process are available elsewhere.[23]

## MEASURES

### *Independent Variable: Chronic Lung Disease*

Survey participants were asked “Has a doctor, nurse, or other health professional ever told you that you had any of the following?”, with COPD and asthma among the lung conditions listed. A response of “No” regarding asthma and COPD was coded as negative for chronic lung disease (dummy code = 0), whereas a response of “Yes” to

either asthma or COPD was coded as positive for chronic lung disease (dummy code = 1).

*Dependent Variable: Lifetime E-cigarette Use*

Participants were asked if they had ever used an e-cigarette or other electronic "vaping" product, even one time, in their entire life. Responses were dummy coded as follows: No = 0 and Yes = 1. The other BRFSS variable pertaining to e-cigarette use, current e-cigarette use, was also considered for inclusion in the analyses, but this variable was endorsed by so few respondents that it was excluded from the present report. Indeed, in response to reviewer comments, current e-cigarette use was evaluated as a dependent variable and yielded no significant associations.

*Moderating Variable: Binge Drinking*

Participants were asked to report the number of times in the past 30 days they consumed 5 or more drinks (for men) or 4 or more drinks (for women) on one occasion (continuous variable).

Covariates

Sociodemographic variables, including age (18-24, 25-34, 35-44, 45-54, 55-64, and ≥ 65 years), gender (female or male), yearly income (<$15,000; $15,000-$25,000; $25,000-$35,000; $35,000-$50,000; ≥ $50,000), cannabis use, cigarette use, and chronic health conditions (stroke, kidney disease, cancer**,** arthritis, or depressive disorder) were included in our analysis to control for possible confounding.

## DATA ANALYSIS

All data analyses were completed using STATA version 16.1. Logistic regression was used to test the association between chronic lung disease and e-cigarette use, controlling for demographic variables and other chronic health conditions. Moderation was assessed by including interaction terms for the number of binge drinking times in the past 30 days by chronic lung disease status. Beta coefficients (B), standard errors (SE), odds ratios (OR), 95% Confidence interval (CI), t, and *P*-values are reported, with $P < 0.05$ indicating statistical significance.

## RESULTS

Individuals who reported a history of chronic lung disease were more likely to be female and older and to have lower income than those who did not report a history of chronic lung disease (Table 1). Participants with chronic lung disease reported greater lifetime e-cigarette use and fewer binge drinking episodes than those without chronic lung disease (Table 2).

A statistically significant interaction was found between chronic lung disease and the number of binge drinking episodes in the past 30 days such that the association between chronic lung disease and e-cigarette use was weaker among those who engaged in more episodes of binge drinking (β, -.056; 95% CI, -.108 to -.004). Further, chronic lung disease was associated with a higher odds of using e e-cigarettes (OR, 1.39; 95% CI, 1.19 to 1.63). Binge drinking was associated with a higher odds of lifetime e-cigarette in

individuals without chronic lung disease (OR, 1.018; 95% CI 1.00 to 1.037); however, binge drinking was not associated with odds of lifetime e-cigarette in individuals with chronic lung disease (OR, .963; 95%.918 to 1.01).

## DISCUSSION

Using the 2018 BRFSS dataset, we found that in the United States adult population chronic lung disease was associated with an increased odds of e-cigarette use. This finding is consistent with prior research indicating that e-cigarette use was more prevalent in individuals with chronic lung disease than in individuals without chronic lung disease.[11] This finding may be related to the high rate of combustible cigarette use among individuals with chronic lung disease.[25] It seems likely that those with chronic lung disease use e-cigarettes for the same reasons as other adults: to quit using or reduce the harm of combustible cigarettes.[12, 13] The increased frequency of e-cigarette use among participants with chronic lung disease may also be explained by a prominent model of addiction motivation described by Baker et al., which contends that the avoidance or escape from negative affect may form the motivational basis for using substances such as e-cigarettes.[26] Perhaps those with chronic lung disease turn to e-cigarettes to temporarily alleviate the emotional distress associated with their health condition.

We also demonstrated that more frequent binge drinking was associated with e-cigarette use among adults, independent of chronic lung disease status. Notably, for those without chronic lung disease, binge drinking was associated with an increased likelihood of e-cigarette use. Consistent with this finding, a prior study reported that weekly,

monthly, and occasional binge drinkers are more likely to use e-cigarettes than are non-binge drinkers.[27]

Contrary to our hypothesis, however, the association between chronic lung disease and e-cigarette use was weaker among those who reported more frequent binge drinking episodes. Similar to e-cigarette use, binge drinking aggravates respiratory symptoms and decreases lung function parameters.[28] Thus, individuals with chronic lung disease who reported more frequent binge drinking may use e-cigarettes less frequently, despite an increased likelihood of having ever used e-cigarettes, over concerns that e-cigarette use could further worsen the adverse pulmonary effects of binge drinking (perhaps as a result of direct experience).[28] Alternatively, individuals with chronic lung disease may be unaware of the lung damage caused by binge drinking, and thus consider binge drinking as a safer alternative to using e-cigarettes. Nevertheless, future experimental and longitudinal studies are necessary to explore this possibility.

Our study has two primary implications. First, because those with chronic lung disease are more likely to use e-cigarettes, targeted interventions ranging from cessation treatments (e.g., nicotine replacement therapy and behavioral counseling) to public health messaging are needed to reduce this deleterious behavior in this population. Second, because individuals with chronic lung disease who do not use e-cigarettes may be more likely to binge drink, clinicians and public health professionals need to carefully attend to alcohol consumption in this population, as this behavior may be easily overlooked considering the obvious relevance of inhaled tobacco products.

The current study has a number of limitations as well. First, our findings are based on self-reported responses, which increase the potential for response bias. Chronic

lung disease status was determined on the basis of a subjective measure, not a clinical diagnosis that would indicate the degree of severity and acuity. Second, we used a cross-sectional design, which provides only a snapshot of what is occurring at the time of data collection and thus only allows conclusions about associations, not causality. Indeed, the temporal relationships between chronic lung disease, binge drinking, and e-cigarette use cannot be definitively established. Third, current e-cigarette use was not included in the analyses because it was endorsed by so few respondents (post-hoc evaluation of current e-cigarette use as a dependent variable yielded no significant associations). Our primary outcome variable, lifetime e-cigarette use, further limited causal inferences insofar that for many respondents, this outcome would have preceded the moderating variable of binge drinking. Fourth, the association between binge drinking and lifetime e-cigarette was modest, as was the modifying effect of binge drinking on the relationship between chronic lung disease and e-cigarette use; however, these small effects may nevertheless be meaningful at the population level.[29] Fifth, we did not explore all possible interactions among tobacco, cannabis, alcohol, and e-cigarette use. These are topics for future research. Finally, the study findings are specific to people in the United States and may not be generalizable to populations in other countries.

In summary, our findings suggest that lifetime e-cigarette use is elevated among adults with a history of chronic lung disease. Our findings also indicate that binge drinking is positively associated with e-cigarette use among individuals without chronic lung disease whereas it was negative in individuals with chronic lung disease, yet binge drinking negatively moderates the relationship between chronic lung disease and e-

cigarette use and. The latter finding necessitates further studies to determine causal mechanisms.

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**Table 1. Sociodemographic Characteristics of Sample Respondents**

| Variable | Not Reported Chronic Lung Disease (No)<br><br>$_{w}N$ = 209,104,888<br><br>(%) | Reported Chronic Lung Disease<br><br>$_{w}N$ = 4,708,808<br><br>(%) | $\chi 2$/*P*-value |
|---|---|---|---|
| **Gender** | | | 1626.976 |
| Female | 49.94 | 57.85 | |
| Male | 50.06 | 42.15 | 0.001 |
| **Age (y)** | | | |
| 18-24 | 12.12 | 13.33 | |
| 25-34 | 17.83 | 15.60 | 1086.59 |
| 35-44 | 16.84 | 13.88 | |
| 45-54 | 16.54 | 15.62 | <0.001* |
| 55-64 | 16.35 | 17.94 | |
| ≥ 65 | 20.32 | 23.62 | |
| **Annual Income** | | | 4336.092 |
| < $15,000 | 9.132 | 15.21 | |
| $15,000-$25,000 | 15.05 | 20.46 | 0.000 |
| $25,000-$35,000 | 9.966 | 10.79 | |
| $35,000-$50,000 | 12.99 | 11.9 | |
| ≥ $50,000 | 52.86 | 41.65 | |
| Missing | 17.9 | 18.02 | |
| **Chronic Health Conditions** | | | **$\chi 2$/*P*-value** |
| **Stroke** | | | 3406.39 |
| No | 97.22 | 93 | |
| Yes | 2.60 | 6.66 | <0.001* |
| Missing | .17 | .21 | |
| **Kidney Disease** | | | 1775.992 |
| No | 97.43 | 94.56 | |
| Yes | 2.571 | 5.438 | 0.000 |
| **Skin Cancer** | | | 613.166 |
| No | 94.21 | 91.87 | |
| Yes | 5.787 | 8.134 | 0.000 |
| **Arthritis** | | | 1.05e+04 |
| No | 77.55 | 59.98 | |
| Yes | 22.45 | 40.02 | 0.000 |
| **Depressive Disorder** | | | |
| No | 85.03 | 67.28 | 1.37e+04 |
| Yes | 14.97 | 32.72 | |

| | | | |
|---|---|---|---|
| | | | 0.000 |
| **Current Smoking Status** | | | 3777.499<br><br>0.000 |
| Non-current smoker | 86.19 | 77.34 | |
| Current smokers | 13.81 | 22.66 | |
| **Cannabis use** | .966 (4.817) | 1.529 (6.104) | -14.544<br><br>0.000 |

**Table 2. Lifetime E-cigarette Use and Binge Drinking in Individuals with and without Chronic Lung Disease.**

| | **No Reported Chronic Lung Disease** | **Reported Chronic Lung Disease** | **χ2/p-value** |
|---|---|---|---|
| **Lifetime E-cigarette Use** | **%** | **%** | 2021.596<br><br>0.001 |
| No | 79.05 | 69.64 | |
| Yes | 20.95 | 30.36 | |
| | **Number of Episodes Mean (SD)** | **Number of Episodes Mean (SD)** | **t-value/p-value** |
| **Binge Drinking Episodes in the past 30 days**<br><br>Mean (SD) | N= 174,328<br><br>1.158, (3.829) | N= 34,960<br><br>1.447, (4.681) | -12.330<br><br>0.000 |

e-cigarette, electronic cigarette; SD, standard deviation.

Table 3. Weighted Multivariable Models of the Association Between Chronic Lung Disease and Lifetime E-Cigarette with Binge Drinking as a Moderating Variable.

| **Results of Logistic Regression Model**<br><br>wN = 27,170,843 | **(β); 95% CI** | **SE** | **t** | **Sig** | **(OR); 95%CI** |
|---|---|---|---|---|---|
| Chronic Lung Disease | (.330); .171, .489 | .0813 | 4.06 | .000 | (1.391); 1.186 ,1.631 |
| Binge Drinking for those without Chronic Lung Disease | (.018); .001, .063 | .009 | 2.02 | .044 | (1.018); 1.00, 1.037 |
| Binge Drinking for those with Chronic Lung Disease | (-.038); -.086, .010 | -1.54 | 0.123 | 0.123 | (.963); .918, 1.01) |
| Chronic Lung Disease status × Binge Drinking Frequency (Interaction) | (-.056); -.108, -.004 | .0263 | -2.14 | .033 | (.945); .898, .995 |
| Cannabis use | (.059); .01, .049 | .004 | 14.07 | .000 | (1.061); 1.052,1.069 |
| Cigarette Smoking | (2.121);1.976, 2.266 | .074 | 5.99 | .000 | (8.336); 7.211, 9.637 |
| Male | (.236).121, .351 | .059 | 4.03 | .000 | (1.267); 1.129, 1.421 |
| 25-34 years | (-.886); -1.091, -.682 | .104 | - 8.51 | .000 | (.412); .336, .505 |
| 35-44 years | (-1.615); -1.823, -1.407 | .106 | -15.21 | .000 | (.199); 162,.245 |
| 45-54 years | (-2.038); -2.259, -.1.818 | .112 | -18.15 | .000 | (.130) .104 to .162 |
| 55-64 years | (-2.427); -3.327, -2.857 | .116 | -20.94 | .000 | (.088); .070, .111 |
| ≥ 65 years | (-3.092); -3.327, -2.857 | .119 | -25.82 | .000 | (.045); .0359, .057 |
| Income $15,000-$25,000 | (.151); -.127, .429 | .142 | 1.07 | .286 | (1.163); .881, 1.535 |
| Income $25,000-$35,000 | (.197); -.076, .470 | .139 | 1.41 | .159 | (1.217); .926, 1.601 |
| Income $35,000-$50,000 | (.384); .122, .647 | .133 | 2.87 | .004 | (1.468);1.129, 1.909 |
| Income ≥ $50,000 | (.165); -.055, 386 | .112 | 1.47 | .141 | (1.179); .946,1.471 |
| Stroke | (-.315); -.138, .767 | .231 | 1.36 | .173 | (1.369); .871, 2.153 |
| Kidney Disease | (-.319); -.750,.113 | .220 | -1.45 | .148 | (.727); .472,1.119 |
| Cancer | (-.041); -.296, .214 | .130 | -.32 | .751 | (.959); .474,1.238 |
| Arthritis | (.091); -.142, .324 | .119 | .77 | .442 | (1.202); 1.037,1.395 |
| Depressive Disorder | (.438) .295, .581 | .073 | 5.99 | .000 | (1.54); 1.343, 1.788 |
| Intercept | (-.411); -.675, -.148 | .134 | -3.06 | .002 | (.663); .509, 862 |

CI, confidence interval; SE, standard error. Source: Behavioral Risk Factor Surveillance (BRFSS), 2018

# THE INFLUENCE OF MENTAL HEALTH AND RESPIRATORY SYMPTOMS ON THE ASSOCIATION BETWEEN CHRONIC LUNG DISEASE AND E-CIGARETTE USE IN ADULTS IN THE UNITED STATES

by

MOHAMMED M. ALQAHTANI, GREGORY PAVELA, DONALD H. LEIN JR, RUZMYN VILCASSIM, PETER S. HENDRICKS

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ABSTRACT

Introduction

Adults with chronic lung disease use e-cigarettes at higher rates than those without chronic lung disease. As e-cigarettes have now been shown to cause adverse pulmonary effects and impair immune responses, it is particularly important to identify the factors that contribute to e-cigarette use in individuals with chronic lung disease. We tested whether mental health explains the association between chronic lung disease and e-cigarette use, and whether the association between chronic lung disease and e-cigarette use is conditional on the presence of respiratory symptoms.

Methods

Data were obtained from the 2018 Behavioral Risk Factor Surveillance System. Logistic regression was used to test the association between chronic lung disease status and e-cigarette use, controlling for demographic variables and comorbidities. Structural equation modeling was then used to evaluate a) whether the number of bad mental health days in the past 30 days explained the association between chronic lung disease and e-cigarette use; and b) if respiratory symptoms moderated the association between chronic lung disease and e-cigarette use.

Results

The prevalence of lifetime and current e-cigarette use was significantly higher in those with chronic lung disease than in those without, as was the number of bad mental health days in the past 30 days. Mediation analysis indicated a statistically significant indirect effect of chronic lung disease on the likelihood of e-cigarette use (lifetime and current) through mental health. However, our analyses did not indicate a statistically

significant interaction between chronic lung disease and respiratory symptoms in the likelihood of e-cigarette use.

Conclusion

The association between chronic lung disease and e-cigarette use may be due, in part, to poorer mental health among individuals with chronic lung disease. These findings provide preliminary evidence that improving the mental health of individuals with chronic lung disease could reduce e-cigarette use in this vulnerable population.

Key words: Asthma, COPD, chronic lung disease, respiratory symptoms, e-cigarette, mental health.

Quick Look

Current knowledge

Little is known about the relationship between chronic lung disease and e-cigarette use or the potential effects of mental health and respiratory symptoms on this relationship.

What this paper contributes to our knowledge

- This study shows that mental health may mediate the association between chronic lung disease and lifetime/current e-cigarette use.
- This finding suggests that improved mental health care may reduce the likelihood of e-cigarette use among those with chronic lung disease.
- Because individuals with chronic lung disease who use e-cigarettes may be more likely to report poorer mental health, clinicians and public health professionals (e.g., respiratory therapists) need to screen for mental health conditions in this population, as mental health conditions may lead to e-cigarette use and poorer control of chronic lung disease.
- Our results indicate that the presence of respiratory symptoms does not make individuals with chronic lung disease more or less likely to use e-cigarettes.
- Our study suggests that healthcare providers such as respiratory therapists need to be trained to screen and refer individuals with chronic lung disease to mental health providers.

# INTRODUCTION

Chronic lung diseases such as asthma and chronic obstructive pulmonary disease (COPD) are serious health conditions that affect multiple physiological functions in humans.[1] In 2017, chronic lung disease was the fourth leading cause of death in the United State.[2] Tobacco smoking remains the leading preventable cause of illness and premature death worldwide.[3, 4] In 2015, it caused more than one-tenth of worldwide deaths, killing around 6 million people, and was associated with a global loss of nearly 150 million disability-adjusted life-years.[4] Furthermore, individuals with chronic lung disease who are smokers have a higher frequency of respiratory symptom exacerbation and decreased pulmonary function parameters.[5, 6] Smoking is thus highly discouraged in individuals with chronic lung disease.[7]

In recent years electronic cigarettes (e-cigarettes), which deliver aerosolized nicotine to the lung without requiring tobacco combustion, have grown in popularity.[8,9] Likely because e-cigarettes have been advertised as a less harmful substitute for traditional cigarettes,[10] the use of traditional cigarettes has decreased while the use of e-cigarettes has increased in the United States since e-cigarettes were introduced in 2007.[9, 11] In 2018, the prevalence of current e-cigarette use among adults in the United States was 3.2%.[12] Another study showed that the percentage of adults in the United States who are currently using an e-cigarette is as follows: 18–24 years old (5.3%), 25–34 years old (3.6%), 35-44 years old (2.3%), 45-54 years old (1.7%), 55–64 years old (1.5%), and 65 years old and over (0.6%).[13]

Despite being touted as a safer alternative to combustible cigarettes, mounting evidence suggests the importance of avoidance and regulation of e-cigarette use because

it is an emerging public health concern and has adverse effects on human health.[14] In addition to nicotine, e-cigarette liquids often contain other harmful ingredients such as solvents comprising propylene glycol, glycerin, heavy metals, and one or more flavorings, which when heated produce aerosols that can be inhaled deep into the lung.[15, 16] Evidence from a study in which human induced pluripotent stem cell-derived endothelial cells were exposed to the serum of e-cigarette users suggested that e-cigarette use increases the production of reactive oxygen species in endothelial cells, leading to endothelial dysfunction, which has been implicated in the pathogenesis of cardiovascular disease.[17] Furthermore, another study exhibits that e-cigarette exposure led to the onset of cardiovascular disease similar to that with tobacco cigarette smoking.[18] Moreover, previous research has found that certain innate immune system cell types, such as the airway epithelium, lung macrophages, and neutrophils, are impaired by e-cigarette use.[19] Inhalation of e-cigarette vapor may alter lung physiology by increasing airway reactivity, inflammation, obstructive lung function impairment, and resistance.[20-22] Additionally, e-cigarette users who have chronic lung diseases such as asthma and Chronic Obstructive Pulmonary Disease (COPD) reported that e-cigarette use exacerbates respiratory symptoms, including throat irritation, shortness of breath, asthma exacerbation, cough, chest tightness, abnormal lung mechanics, and airway resistance.[21, 23-27] There is also another study that showed e-cigarette induce airway epithelium toxicity similar to cigarette smoke toxicity in individuals with COPD.[28] Despite the adverse pulmonary effects of e-cigarettes, it appears that the prevalence of e-cigarette use among adults with chronic lung disease is high.[29, 30] This finding suggests that individuals with chronic lung disease might perceive e-cigarettes as a safer substitute for traditional combustible

cigarettes.[30-33] In fact, individuals with COPD or asthma who smoke reported using e-cigarettes to minimize the adverse health effects of smoking or to decrease their use of traditional cigarettes.[30, 31, 33-35]

Importantly, it is not yet known if e-cigarettes can cause chronic lung disease. Indeed, cross-sectional research shows only that there is an association between e-cigarette use and chronic lung disease at a single point in time.[36-38] Though it stands to reason that chronic e-cigarette use could ultimately cause chronic lung disease, longitudinal research demonstrating e-cigarette use predicts later chronic lung disease has not yet been conducted. This is understandable considering e-cigarettes are relatively new to the market—longitudinal research would be limited to very discrete time intervals that would likely prove insufficient to detect causal relationships. The effect of e-cigarette use on chronic lung disease notwithstanding, there is a lack of research on factors that might explain why those with chronic lung disease are more likely to use e-cigarettes.

Modifiable psychological factors that may increase (or decrease) e-cigarette use among those with chronic lung disease are poorly understood. Mental health conditions, such as depression and anxiety, may lead to smoking initiation and maintenance. Compared with the general population, individuals who experience depression and anxiety are apt to smoke at an earlier age, smoke more heavily, and become more addicted to cigarettes.[39] Indeed, several studies have found support for the negative reinforcement model of drug addiction (sometimes referred to as the "self-medication" model), in which individuals with mental health conditions use substances such as tobacco to regulate some of the associated psychological symptoms.[40, 41] A growing body of literature has also found that mental health conditions are common among individuals

with chronic health conditions. For example, one study indicated that anxiety and depression are common among people with COPD; in particular, this population is 10 times more likely than the general population is to have panic disorder or panic attacks.[42] Furthermore, mental health conditions such as anxiety and depression have been reported to be prevalent among adults with asthma.[43, 44] Further, previous research has demonstrated that those with mental health conditions seem to have less accurate information concerning harm perception of e-cigarette use than individuals without mental health conditions.[45] However, little is known concerning the relationship between mental health and e-cigarette use in individuals with chronic lung disease.

In addition, the presence of respiratory symptoms may influence the risk of e-cigarette use among individuals with chronic lung disease. Although e-cigarettes are not risk free, they have been promoted as a much less harmful if not harmless method of nicotine delivery that can help smokers quit smoking, keep former smokers from relapsing, and prevent nonsmokers from initiating smoking.[46] Thus, individuals with respiratory symptoms might use e-cigarettes, rather than traditional cigarettes, as a harm reduction strategy. However, the influence of respiratory symptoms on the likelihood of e-cigarette use among individuals with chronic lung disease has not yet been investigated.

The current study was designed to determine: 1) whether the association between chronic lung disease status and e-cigarette use is mediated by mental health; and 2) whether the association between chronic lung disease status and e-cigarette use is moderated by respiratory symptoms. We hypothesized that 1) chronic lung disease would be associated with poorer mental health, which would in turn be associated with a greater

likelihood of e-cigarette use; and 2) the association between chronic lung disease and e-cigarette use would be stronger among those who report respiratory symptoms.

## METHODS

### Design and Data Sources

This study used data from all adults (≥ 18 years old) in the Behavioral Risk Factor Surveillance System (BRFSS, 2018),[47] which used a cross-sectional research design. The BRFSS collects data regarding the health-related risk behaviors, chronic health conditions, and preventive service use of residents in the United States. Information regarding BRFSS sampling and the questionnaire methodology can be found on the Centers for Disease Control website (https://www.cdc.gov/brfss/annual_data/annual_2018.html).[48] The protocol and the model in this study were pre-registered with ClinicalTrials.gov (NCT04135404) before data were analyzed.

## MEASURES

### *Independent Variable: Chronic Lung Disease*

Survey participants were asked the following question: "Has a doctor, nurse, or other health professional ever told you that you had any of the following?" with COPD and asthma among the lung conditions listed as potential responses. A response of "No" regarding asthma and COPD was coded as negative for chronic lung disease (code = 0), whereas a response of "Yes" to either asthma or COPD was coded as positive for chronic lung disease (code = 1).

*Dependent Variables:*

*Lifetime E-cigarette Use*

Survey participants were asked if they had ever used an e-cigarette or other electronic "vaping" product, even one time, in their entire life. "Yes" responses were coded as "1" and "No" responses coded as "0."

*Current E-cigarette Use*

Survey participants who answered "Yes" to the above question about lifetime e-cigarette use were then asked, "Do you now use e-cigarettes every day, some days, or not at all?" A dichotomous variable of current e-cigarette use was created, with a response of no current e-cigarette use (i.e., "not at all") coded as "0" and a response of current e-cigarette use (i.e., "every day" or "some days") coded as "1."

*Mediating Variable:*

*Mental Health*

Survey participants were asked "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" The responses ranged from 0 to 30 days and were recorded as a continuous variable.

*Moderating Variable:*

*Presence of Respiratory Symptoms*

Survey participants were asked the following three questions: "During the past 3 months, did you have a cough on most days?", "During the past 3 months, did you cough

up phlegm or mucus on most days?", and "Do you have shortness of breath either when hurrying on level ground or when walking up a slight hill or stairs?" A response of "No" for each question was coded as negative for the presence of symptoms (code = 0), whereas a response of "Yes" to any of the three questions was coded as positive for the presence of symptoms (code = 1).

*Covariates*

Analyses were adjusted for the following covariates: age (18-24, 25-34, 35-44, 45-54, 55-64, and ≥ 65 years old), sex (female or male); race (White, Black, Hispanic, Multiracial, and Other); educational attainment (did not graduate high school, graduated high school, attended college or technical school, and graduated from college or technical school); annual income (<$15,000; $15,000 to <$25,000; $25,000 to <$35,000; $35,000 to <$50,000; and ≥ $50,000); smoking status (never smoker, former smoker, or current smoker); and comorbidity (stroke, kidney disease, cancer, arthritis, or heart disease; each comorbidity coded separately).

## DATA ANALYSIS

Stata version 16.1 was used to conduct the analyses, including descriptive statistics and chi-square tests of independence comparing those with chronic lung disease to those without chronic lung disease. Prevalence is reported in weighted percentages and analyses were weighted to account for the complex survey design.

Structural equation modeling was used to test whether mental health mediates the relationship between chronic lung disease status (having chronic lung disease versus not having chronic lung disease) and e-cigarette use (lifetime and current). Moderation analyses were conducted to test the hypothesis that the association between chronic lung

disease and e-cigarette use would be modified by the presence or absence of respiratory symptoms. Models testing for mediation or moderation were weighted to control for the complex survey design of the BRFSS ,[47] and statistical inferences about the indirect effect were based on the Sobel test.[49, 50] A p-value < 0.05 indicated statistical significance.

## RESULTS

The sociodemographic characteristics of the respondents, grouped according to chronic lung disease status, are presented in Table 1. Those who reported having chronic lung disease were more likely to report being female, ≥ 65 years old, White, earning an annual income of ≥ $50,000, and having attended college or technical school, and non-current smokers (never smokers, and former smokers). Those who reported chronic lung disease also reported fewer other chronic health conditions (arthritis, kidney disease, skin cancer, other type of cancer, and depressive disorders) than those without chronic lung disease.

As shown in Table 2, chronic lung disease, poorer mental health status, and the presence of respiratory symptoms were each associated with higher odds of lifetime e-cigarette use. In models predicting current e-cigarette use only, chronic lung disease and poorer mental health status were each associated with a higher likelihood of current e-cigarette use. However, the presence of respiratory symptoms was not associated with higher odds of current e-cigarette use.

### Mediation Analyses

Figure 1 reports results of analyses testing whether the association between chronic lung disease and e-cigarette use can be explained, in part, by the association between chronic lung disease and mental health. As depicted in Figure 1a, the direct effect of chronic lung disease status on odds of lifetime e-cigarette use was statistically significant (β = 0.047; 95% CI, 0.038 to 0.056). In addition, chronic lung disease status was associated with a greater number of bad mental health days in the past 30 days (β = 1.999; 95% CI, 1.848 to 2.149), which in turn was a significant predictor of lifetime e-cigarette use (β = 0.004; 95% CI, 0.003 to 0.004). Consistent with mediation, the indirect effect of chronic lung disease status on the likelihood of lifetime e-cigarette use through mental health was statistically significant (β = 0.008; 95% CI, 0.007 to 0.009).

As depicted in Figure 2, the direct effect of chronic lung disease status on odds of current e-cigarette use was also statistically significant (β = 0.019; 95% CI, 0.003 to 0.037). Chronic lung disease status was associated with a greater number of bad mental health days in the past 30 days (β = 1.999; 95% CI, 1.848 to 2.149), which in turn was a significant predictor of current e-cigarette use (β = 0.002; 95% CI, 0.001 to 0.003). Consistent with mediation, the indirect effect of chronic lung disease status on the likelihood of current e-cigarette use through mental health was statistically significant (β = 0 .004; 95% CI, 0.003 to 0.006).

Moderation Analyses

Contrary to our hypotheses, there was not a statistically significant interaction between chronic lung disease and the presence of respiratory symptoms regarding the odds of lifetime e-cigarette use (β = -0.051; 95% CI, -0.285 to 0.184). Furthermore, there

was not a statistically significant interaction between chronic lung disease and respiratory symptoms regarding the odds of current e-cigarette use (β = -0.104; 95% CI, -0.517 to 0.30).

## DISCUSSION

Previous research suggests that e-cigarette use is more prevalent among people with chronic lung disease than among those without chronic lung disease,[33] yet the reasons for this discrepancy have not been well studied. Our analysis of cross-sectional data from a nationally representative sample of adults in the United States found increased odds of current and lifetime e-cigarette use among individuals with chronic lung disease compared with those without chronic lung disease. Further analysis indicated that poorer mental health explains, in part, the association between chronic lung disease and e-cigarette use. However, contrary to our hypothesis, the strength of the relationship between chronic lung disease and e-cigarette use was not modulated by the presence of respiratory symptoms; our results indicate that the presence of symptoms does not make someone with chronic lung disease more or less likely to use e-cigarettes.

It is possible that many adults with chronic lung disease use e-cigarettes for the same reasons that people without chronic lung disease do: to stop using traditional cigarettes, as e-cigarettes have been touted as a safer alternative.[34, 35] Nonetheless, a growing number of studies indicate e-cigarettes have negative pulmonary impact and undesirable health outcomes;[51] Even short-term e-cigarette use may provoke or exacerbate respiratory responses, including dry cough, throat and airway irritation, and mucus hypersecretion, and wheezing, and hemoptysis, and promote changes in respiratory function and host immune responses.[46, 52-54] Furthermore, continued e-

cigarette use could lead to peripheral airway resistance, difficulty breathing, inadequate gas exchange, and ultimately reliance on oxygen.[24, 55]

That mental health contributes to the association of chronic lung disease with lifetime and current use of e-cigarettes may be explained by the negative reinforcement model of drug addiction. This model posits that the escape or avoidance of negative affect comprises the motivational foundation for compulsive drug use.[41] Individuals with chronic lung disease may thus use e-cigarettes to alleviate mental health symptomatology associated with chronic disease.[40, 41] Our findings are consistent with previous studies that identified an association between poor mental health and e-cigarette use.[56-59] Indeed, our previous analysis of BRFSS data showed that poor mental health accounts for the increased prevalence of e-cigarette use in young adults with asthma.[32]

Our data suggest that the presence of respiratory symptoms is associated with lifetime e-cigarette use among adults in the United States. This finding is corroborated by a previous study that indicated respiratory symptoms were prevalent among e-cigarette users.[60] This finding also supports the work of one previous study in this area linking respiratory symptoms such as cough, phlegm, and shortness of breath with e-cigarette use.[61] However, the results of our moderation analysis indicated that the association between chronic lung disease and lifetime or current e-cigarette use among adults in the United States is not influenced by the presence of respiratory symptoms.

Considering the potential for adverse cardiopulmonary effects in people with chronic lung disease, tailored interventions ranging from cessation treatments (e.g., pharmacotherapy and behavioral counseling) to public health messaging are needed to prevent or reduce the use of e-cigarettes in this vulnerable population. Although further

research is necessary, our results suggest that the provision and utilization of mental health services among individuals with chronic lung disease may decrease their risk of using e-cigarettes. Moreover, increased efforts by clinicians and public health professionals are greatly encouraged to screen for mental health conditions as well as tobacco product use (including use of e-cigarettes) and to either refer individuals to or provide cessation services to improve health outcomes among individuals who have chronic lung disease.

Several limitations of this study exist. First, this study relied on self-reported data, which may have obscured the true relationships between chronic lung disease status, respiratory symptoms, mental health, and e-cigarette use. Importantly, it is noted that chronic lung disease status lacked a formal clinical diagnosis that would have indicated the degree of severity and acuity. Second, the cross-sectional design of this study provided only a glimpse of what was occurring at the time of data collection and thus only allows conclusions about associations, not causality. The temporal relationships between chronic lung disease, mental health, and e-cigarette use cannot be established from this analysis. Further, the type of e-cigarette used, and the frequency/quantity of e-cigarette use were unknown. These are variables that should be considered in future studies. Moreover, participants' responses are not precluded from the risk of recall bias. A major advantage of the BRFSS is that it was administered to a large, representative sample. However, as this was a secondary data analysis, we were left to analyze only the available data. Respiratory symptoms such as chest tightness and wheezing (the most characteristic symptom of asthma), for example, were not assessed by the BRFSS, but might play an important role in e-cigarette use. Finally, the association between chronic

lung disease status, mental health, and e-cigarette use was modest, as was the mediating effect of mental health on the relationship between chronic lung disease and e-cigarette use. However, these small effects may nevertheless be meaningful at the population level.[62]

Overall, the current results may advance the understanding of the potential mechanisms underlying the association between chronic lung disease and e-cigarette use. This research is a first step in informing e-cigarette cessation programs among individuals with chronic lung disease and suggests that the provision and utilization of mental health services may be one approach in preventing and treating e-cigarette use and dependence.

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**Table 1. Sample Sociodemographic Characteristics**

| Variable | Not Reported Chronic Lung Disease (No)<br><br>wN = 210,000,000<br><br>wN, (w%) | Reported Chronic Lung Disease<br><br>wN = 47,000,000<br><br>wN (%) | $\chi 2$/*P*-value |
|---|---|---|---|
| **Gender** | | | |
| Female | 100,000,000 (49.84) | 27,000,000 (57.69) | |
| Male | 100,000,000 (49.95) | 20,000,000 (42.02) | 2524.2724 |
| Missing | 430,000 (.2068) | 140,000 (.2897) | < 0.001* |
| **Age (y)** | | | |
| 18-24 | 25,000,000 (12.12) | 6,300,000 (13.33) | |
| 25-34 | 37,000,000 (17.83) | 7,300,000 (15.6) | 1246.9785 |
| 35-44 | 35,000,000 (16.84) | 6,500,000 (13.88) | |
| 45-54 | 35,000,000 (16.54) | 7,400,000 (15.62) | < 0.001* |
| 55-64 | 34,000,000 (16.35) | 8,400,000 (17.94) | |
| ≥ 65 | 42,000,000 (20.32) | 11,000,000 (23.64) | |
| **Annual Household Income** | | | 5623.6421 |
| < $15,000 | 16,000,000 (7.497) | 5,900,000 (12.47) | |
| $15,000-$25,000 | 26,000,000 (12.36) | 7,900,000 (16.77) | < 0.001* |
| $25,000-$35,000 | 17,000,000 (8.182) | 4,200,000 (8.842) | |
| $35,000-$50,000 | 22,000,000 (10.66) | 4,600,000 (9.759) | |
| ≥ $50,000 | 91,000,0000 (43.4) | 16,000,000 (34.15) | |
| Missing | 37,000,000 (17.9) | 740,000 (18.02) | |
| **Race** | | | |
| White | 130,000,000 (60.99) | 30,000,000 (63.61) | |
| Black | 24,000,000 (11.26) | 6,200,000 (13.21) | 1982.0151 |
| Other | 15,000,000 (7.195) | 2,400,000 (5.178) | |
| Multiracial | 2,300,000 (1.105) | 900,000(1.902) | < 0.001* |
| Hispanic | 37,000,000 (17.51) | 6,600,000(14.11) | |
| Missing | 4,100,000 (1.943) | 940,000 (1.992) | |
| **Education** | | | |
| Did not Graduate high School | 26,000,000 (12.39) | 7,500,000 (16.01) | 2977.0817 |
| Graduated High School | 58,000,000 (27.57) | 14,000,000 (28.7) | < 0.001* |
| Attended College or Technical School | 64,000,000 (30.39) | 15,000,000 (32.45) | |

| | | | |
|---|---|---|---|
| Graduated from College or Technical School | 61,000,000 (29.25) | 11,000,000 (22.59) | |
| Missing | 840,000 (.3998) | 120,000 (.2504) | |
| **Chronic Health Conditions** | | | **$\chi 2$/*P*-value** |
| **Stroke** | | | 19,700 |
| No | 200,000,000 (97.22) | 44,000,000 (93) | |
| Yes | 5,400,000 (2.606) | 3,100,000 (6.662) | < 0.001* |
| Missing | 370,000 (.1747) | 160,000 (.3432) | |
| **Arthritis** | | | 25,000 |
| No | 160,000,000 (77.24) | 28,000,000 (59.62) | |
| Yes | 47,000,000 (22.37) | 19,000,000 (39.78) | < 0.001* |
| Missing | 820,000 (.3921) | 280,000 (.5985) | |
| **Kidney Disease** | | | 14,500 |
| No | 200,000,000 (97.22) | 44,000,000 (94.12) | |
| Yes | 5,400,000 (2.566) | 2,500,000 (5.413) | < 0.001* |
| Missing | 440,000 (.2117) | 220,000 (.4651) | |
| **Skin Cancer** | | | 14,300 |
| No | 200,000,000 (94.06) | 43,000,000 (91.63) | |
| Yes | 12,000,000 (5.778) | 3,800,000 (8.113) | < 0.001* |
| Missing | 350,000 (.1661) | 120,000 (.2614) | |
| **Any Other types of Cancer** | | | 14,900 |
| No | 200,000,000 (93.78) | 42,000,000 (89.5) | < 0.001* |
| Yes | 13,000,000 (6.073) | 4,800,000 (10.14) | |
| Missing | 310,000 (.1474) | 170,000 (.3636) | |
| **Current Smoking Status** | | | |
| Non-current smoker | 170,000,000 (81.97) | 35,000,000 (74.09) | 4061.3832 |
| Current smoker | 27,000,000 (13.13) | 10,000,000 (21.71) | < 0.001* |
| Missing | 10,000,000 (4.903) | 2,000,000 (4.205) | |

$_{w}$N, weighted sample size; w%, weighted percentage; *, p-value < 0.001.

Table 2. Weighted multivariate models of adjusted odds of e-cigarette use among adults in the United States predicted by chronic lung disease status, mental health functioning, respiratory symptoms, and other covariates.

| Variable | **Lifetime E-Cigarette Use** | | |
|---|---|---|---|
| | **β (95% CI)** | **aOR (95%CI)** | **P Value** |
| Chronic lung disease | 0.146 (.026, .265) | 1.157 (1.026, 1.304) | 0.017* |
| Bad mental health days in the past 30 days | 0.024 (.019, .029) | 1.024 (1.019, 1.030) | < 0.001* |
| Presence of respiratory symptoms | 0.354 (.248, .461) | 1.425 (1.281, 1.585) | < 0.001* |
| Chronic lung disease **x** Respiratory symptoms interaction | -0.051 (-.285, .184) | 0.950 (0.752, 1.202) | 0.670 |
| | **Current E-Cigarette Use** | | |
| | **β (95% CI)** | **aOR (95%CI)** | **P Value** |
| Chronic lung disease | 0.0767 (-.133, .287) | 1.079 (.875, 1.33) | 0.473 |
| Bad mental health days in the past 30 days | 0.0202 (0.0117, 0.0288) | 1.020 (1.011, 1.029) | < 0.001* |
| Presence of respiratory symptoms | -0.0239 (-0.225, 0.177) | 0.976 (0.798, 1.193) | 0.816 |
| Chronic lung disease **x** Respiratory symptoms interaction | -0.104 (-0.517, 0.309) | 0.901 (0.596, 1.362) | 0.622 |

Other covariates: sex, educational attainment, race, income, comorbidities (stroke, kidney disease, cancer, arthritis, or heart disease). E-cigarette, electronic cigarette; aOR, adjusted odd ratio; 95% CI, 95% confidence interval; *$p < .05$; ** $p < .0001$.

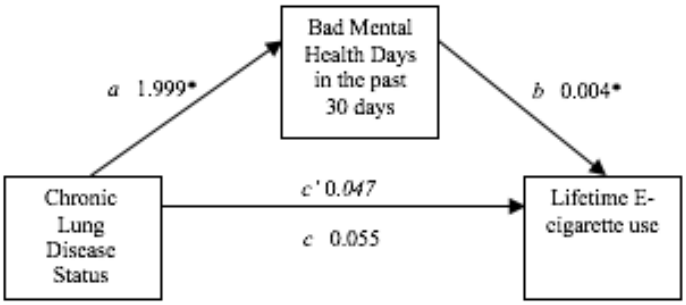


Figure 1Mediated relationship between chronic lung disease status and lifetime e-cigarette use with mental health as the mediator.

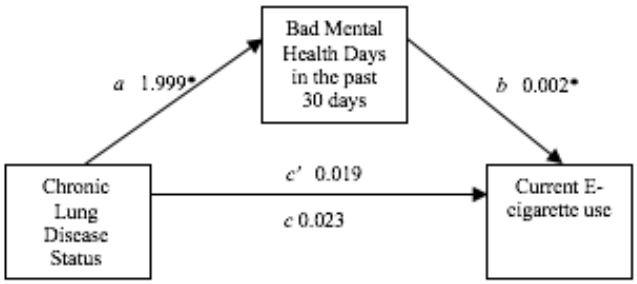


Figure 2Mediated relationship between chronic lung disease status and current e-cigarette use with mental health as the mediator

**Note:** Indirect effect = a*b, c' = direct effect, total effect (c) = c' + a*b. * p < .0001.

# The Relationship Between Chronic Lung Disease Diagnosis and Susceptibility to E-Cigarette Use in Adults: The Moderation Effects of Behavioral, Social, and Environmental Factors

by

MOHAMMED M. ALQAHTANI, ABDULLAH M. M. ALANAZI, MARK T. DRANSFIELD, J. MICHAEL WELLS, DONALD H. LEIN JR, PETER S. HENDRICKS

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ABSTRACT

Introduction

Electronic cigarettes (e-cigarettes) are now known to cause adverse pulmonary effects, yet paradoxically, the prevalence of e-cigarette use has increased among individuals with chronic lung disease. We assessed the relationship between chronic lung disease and the susceptibility to e-cigarette use in adults and determined if specific behavioral, social, and environmental factors influence this relationship.

METHODS

We enrolled adults aged ≥ 18 years in Alabama with chronic lung disease from university medical clinics (n = 140) or individuals without chronic lung disease (n = 123; reference group). Questionnaires were administered to collect sociodemographic information and assess susceptibility to e-cigarette use, exposure to social and environmental factors (i.e., advertisements, warning labels, special prices, others' e-cigarette vapors, use of an e-cigarette by others in the home, and visiting a website or online discussion), and behavioral factors (i.e., alcohol and cannabis use). Moderation analyses were conducted to determine if any of these factors would modify the association between chronic lung disease and susceptibility to e-cigarette use.

RESULTS

The susceptibility to e-cigarette use was higher among adults without chronic lung disease than among those with chronic lung disease. Noticing e-cigarette warning labels and visiting a website or online discussion about e-cigarettes were significantly associated with an increased likelihood of susceptibility to using e-cigarettes in both groups. Exposure to e-cigarette vapor from close contacts, special pricing, living with someone who uses e-

cigarettes, and cannabis use were significantly associated with an increased likelihood of susceptibility to e-cigarette use in individuals without chronic lung disease. However, our analyses did not indicate a statistically significant interaction between chronic lung disease and any of the social and environmental or behavioral factors on the susceptibility to e-cigarette use.

CONCLUSION

Individuals without chronic lung disease were more susceptible to e-cigarette use than were those with chronic lung disease who utilized medical treatment. Although the prevalence of some behavioral and environmental factors differed among individuals with and without chronic lung disease, these factors did not moderate the association between chronic lung disease and susceptibility to e-cigarette use. Longitudinal investigations are warranted to better test the temporal relationship between chronic lung disease, substance use, social and environmental factors, and the susceptibility to e-cigarette use among individuals with chronic lung disease to identify strategies to prevent e-cigarette use in this population.

Keywords: E-cigarettes, Asthma, COPD, Chronic lung disease, Susceptibility, Predictors, Moderators

# INTRODUCTION

Electronic cigarettes (e-cigarettes) have been promoted as a safer alternative to traditional tobacco products.[1].However, while e-cigarettes do not expose users to the adverse effects of tobacco combustion, accumulating evidence has begun to show that the inhalation of aerosolized chemicals commonly found in e-cigarettes, including propylene glycol and glycerol, can also have a negative impact on health [2]. In particular, much research has demonstrated that e-cigarette use can promote respiratory irritation, abnormalities in lung function parameters, airway epithelial injury, sustained tissue hypoxia, airway flow resistance, and airway reactivity [3, 4]. Despite the potential for such adverse effects on the lung, e-cigarette use has become more prevalent among individuals with chronic lung disease over the past several years [5-8]. Indeed, our recent analysis of data from a large national database, the 2018 Behavioral Risk Factor Surveillance System (BRFSS), revealed that the prevalence of lifetime e-cigarette use was higher among adults with chronic lung disease than among those without [5], confirming similar findings from previous studies [9-11]. In addition to causing adverse health effects directly, e-cigarette use may motivate individuals to start using or increasing the frequency of using tobacco cigarettes as well [12]. Therefore, identifying the factors that lead to e-cigarette use, especially among those with chronic lung disease, is crucial for informing the design of prevention and treatment strategies.

Modifiable behaviors that may influence e-cigarette use specifically among those with chronic lung disease have rarely been studied. However, it has been well established that those who consume alcohol are more likely to smoke cigarettes than are those who do not consume alcohol [13-15]. Therefore, it is perhaps not surprising that a positive

association between alcohol consumption and the likelihood of using e-cigarettes was identified in a recent study of young adults in the United States[16]. More recently, our analysis of BRFSS data showed that binge drinking was positively associated with e-cigarette use among adults with or without chronic lung disease in the United States [5].

As with alcohol consumption, the use of cannabis has been highly correlated with the use of tobacco among adolescents and young adults worldwide [17]. Furthermore, recent studies showed a positive relationship between cannabis use and the likelihood of e-cigarette use among adolescents and adults in the United States [18-21]. Nevertheless, no study has examined the association between cannabis use and the susceptibility to e-cigarette use in individuals with chronic lung disease.

In addition to modifiable behaviors, research indicates that environmental and social factors influence the susceptibility to initiating e-cigarette use among adolescents and adults [22-26]. Among the potential environmental factors driving e-cigarette use, the influence of advertising may be particularly important, especially considering the e-cigarette industry has long marketed e-cigarettes as a healthy alternative to cigarette smoking [27, 28]. The United States Food and Drug Administration (FDA) now requires a health warning on all tobacco products and e-cigarette advertising but imposes no additional restrictions on e-cigarette marketing [29]. Of note, Nicksic, et al. [30] recently reported that increased exposure to tobacco marketing resulted in a significantly greater belief that e-cigarettes lack nicotine and are less addictive than conventional cigarettes. In addition, exposure to e-cigarette advertising was associated with increased susceptibility to future e-cigarette use, especially among those who received coupons [30, 31]. Similar to the reported benefits of adding warnings for combustible cigarettes [32], however, Berry, et

al. [33] found that adults who smoke combustible cigarettes or use e-cigarettes are less willing to try an advertised e-cigarette if the advertisement includes an addiction warning. Additional social factors that could influence a person's susceptibility to e-cigarette use include living with a person who uses e-cigarettes and exposure to e-cigarette vapor generated by others [26, 34]. However, the influence of social and environmental factors on the susceptibility to e-cigarette use among individuals with chronic lung disease remains unknown.

In the present investigation, we sought to determine whether social, environmental, or behavioral factors moderate the association between chronic lung disease status and susceptibility to e-cigarette use. We hypothesized that the association between chronic lung disease and susceptibility to using e-cigarettes would be stronger among those who reported alcohol use, cannabis use, or exposure to certain social or environmental factors (i.e., advertisements, special prices, others' e-cigarette vapors, use of an e-cigarette by others in the home, and visiting a website or online discussion). We also hypothesized that the association between chronic lung disease and susceptibility to using e-cigarettes would be weaker among those who reported exposure to warning labels advertisements.

## METHOD

This study recruited two groups of individuals aged ≥18 years based on their chronic lung disease status from January 2020 to March 2021. One group (n=141) consisted of individuals with a diagnosis of chronic lung disease (obstructive lung diseases based on the International Classification of Diseases, Tenth Revision (ICD-10)) who sought chronic lung disease-related medical management at an outpatient health care

clinic. These individuals were recruited in person through a questionnaire packet given to anyone treated at the University of Alabama at Birmingham (UAB) outpatient pulmonary clinic (the Kirklin Clinic of UAB Hospital) or the UAB Lung Health Center who expressed interest in participating in the study. Additional individuals with chronic lung disease in the UAB clinical databases with a diagnosis of chronic lung disease were recruited by email or mail. These individuals received a recruitment flyer that included information about the study and a personalized link to a web-based survey option.

The second group consisted of individuals without chronic lung disease (n=123) and served as the control/reference group. Individuals in this group were recruited through purposive convenience sampling using distributed recruitment flyers on the UAB campus. Individuals who did not have chronic lung disease and expressed interest in participating were emailed a personalized link to the web-based survey option.

Individuals who were currently using e-cigarettes in both groups were not eligible to participate in the study because the outcome variable was susceptibility to using e-cigarettes. Study participants were compensated financially ($15) for their time. Before commencing this study, ethical clearance was obtained from the University of Alabama at Birmingham's review boards. This study was registered with ClinicalTrials.gov before data were analyzed (NCT04151784).

## MEASURES

Dependent Variable:

*Susceptibility to e-cigarette use:* The questions used to assess susceptibility to e-cigarette use were adopted from a study performed by Nicksic, et al.[30] that adapted validated measures of susceptibility to smoking combustible cigarettes. Each participant's

susceptibility to using e-cigarettes was ascertained based on their answers to the following four questions: “Do you think that you will use an e-cigarette soon?”, “Do you think that, in the future, you might experiment with e-cigarettes?”, “Do you think you will use an e-cigarette in the next year?”, and “If one of your best friends were to offer you an e-cigarette, would you smoke it?” Responses were as follows: “Definitely not,” “Probably not,” “Probably yes,” and “Definitely yes.” A summary measure of susceptibility to e-cigarette use was created based on responses to these four items such that a participant was classified as not susceptible to e-cigarette use if they responded, “Definitely not” to all four items or susceptible to e-cigarette use if they responded, “Probably not,” “Probably yes,” or “Definitely yes” to any of the four items.

Independent Variable:

*Chronic lung disease status:* Participants in the reference group (no chronic lung disease) were coded as “0”; participants with any type of chronic lung disease were coded as “1.”

Moderating Variables:

*Environmental factors:*

Advertisements:

Eight questions that have been successfully used in previous Centers for Disease Control and Prevention (CDC) studies were used to assess various environmental factors related to e-cigarette advertisements [35].

E-cigarette internet advertisements:

Participants were asked: “When you are using the internet, how often do you see ads or promotions for e-cigarettes?” Participants responded by selecting from a 6-point Likert scale. A response of “Never” or “I don’t use the internet was coded as “never

exposed" (code = 0), whereas a response of "rarely," "sometimes," "most of the time," or "always" was coded as "exposed" (code = 1).

E-cigarette newspaper or magazine advertisements:

Participants were asked: "When you read newspaper or magazines, how often do you see ads or promotions for e-cigarettes?" Participants then selected a response from a 6-point Likert scale. A response of "Never" or "I don't read the read newspaper or magazines" was coded as "never exposed" (code = 0), whereas a response of "rarely," "sometimes," "most of the time," or "always" was coded as "exposed" (code = 1).

E-cigarette advertisements in a convenience store, supermarket, or gas station:

Participants were asked: "When you go to a convenience store, supermarket, or gas station, how often do you see ads or promotions for e-cigarettes?" Participants then responded by selecting an answer from a 6–point Likert scale. A response of "Never" or "When you go to a convenience store, supermarket, or gas station, how often do you see ads or promotions for e-cigarettes" was coded as "never exposed" (code = 0), whereas a response of "rarely," "sometimes," "most of the time," or "always" was coded as "exposed" (code = 1).

E-cigarette TV advertisements:

Participants were asked: "When you watch TV, how often do you see ads or promotions for e-cigarettes?," Participants then chose from a 6-point Likert scale to answer the question. A response of "Never" or "I don't watch TV or go to the movies" was coded as "never exposed" (code = 0), whereas a response of "rarely," "sometimes," "most of the time," or "always" was coded as "exposed" (code = 1).

Warning labels:

Participants were asked “During the past 30 days, how often did you see a warning label on an e-cigarette package?” Participants responded by selecting an answer from a 6-point Likert scale. A response of “Never” or “I did not see an e-cigarette package during the past 30 days” was coded as “0 = never exposed,” whereas a response of “rarely,” “sometimes,” “most of the time,” or “always” was coded as “1 = exposed” to indicate that they had been exposed to an e-cigarette warning label.

Exposure to e-cigarette vapors from someone else in an indoor or outdoor public place:

Participants were asked “During the past 30 days, on how many days did you breathe the vapor from someone who was using an e-cigarette in an indoor or outdoor public place?” Examples of indoor public places are school buildings, stores, restaurants, and sports arenas. Examples of outdoor public places are school grounds, parking lots, stadiums, and parks. A response of “0 days” was coded as “0 = never exposed”, whereas a response of “1 or 2 days,” “3 to 5 days,” “6 to 9 days,” “10 to 19 days,” “20 to 29 days,” or “all 30 days” was coded as “1 = exposed.”

Exposure to special prices:

Exposure to special price offers for e-cigarettes was assessed by asking “In the last 30 days, have you noticed any special price offers, such as discounts or coupons, for e-cigarettes/vaping devices or e-liquid?” A response of “No” was coded as “0,” and a response of “Yes” was coded as “1.”

Living with someone who uses e-cigarettes:

Participants were asked “Does anyone who lives with you now use e-cigarettes?”

A response of “No” was coded as “0,” and a response of “Yes” was coded as “1.”

Visiting an online discussion forum dedicated to electronic cigarettes:

Participants were asked, “Have you ever visited a website, or an online discussion forum dedicated to electronic cigarettes?.” A response of “No” was coded as “0,” and a response of “Yes” was coded as “1.” This question was successfully used in a previous study [36].

*Behavioral factors (alcohol and cannabis use):*

Alcohol use

Participants were asked to disclose how often they use alcohol. A response of “Never” was coded as “0,” whereas a response of “monthly or less,” “2-4 times a month,” “2-3 times a week,” or “four or more times a week” was coded as “1”. This question was successfully used in a previous study [37, 38]

Cannabis use:

Participants were asked to disclose how often they use cannabis. A response of “Never” was coded as “0 = no,” whereas a response of “monthly or less,” “2-4 times a month,” “2-3 times a week,” or “four or more times a week” was coded as “1 = yes”. This question was successfully used in a previous study [37, 38]

Covariates:

Seven self-reported covariates were incorporated in the analyses: age (range from 18 to 81 years), gender (male or female), race (African American / Black, Asian / Filipino, Pacific Islander / Native Hawaiian, Native Hawaiian, Caucasian / White, American Indian / Alaskan Native, more than one ethnic group, not known, and other), ethnicity (Hispanic, and non-Hispanic), education (less than 12 years of education, high school, Associate in Arts (A.A.) degree or Associate in Science (A.S.) degree or other

vocational program, B.A., B.S., M.A., M.S, Ph.D., M.D., J.D.), income (less than $10,000, $11,000 - $20,000, $21,000 - $30,000, $31,000 - $40,000, $41,000 - $50,000, $41,000 - $50,000, $51,000 - $60,000, $61,000 - $70,000, $71,000 - $80,000, $81,000 - $90,000, $91,000 - $100,000) marital status (married, widowed, divorced or separated, single, never married), and tobacco use (never users, former users, and current users).

## STATISTICAL ANALYSIS

Data analysis was performed using Stata version 16.1. Independent t-tests were used to compare continuous variables and chi-square tests were used to compare nominal variables between groups. Logistic regression was used to test the association between chronic lung disease status and susceptibility to e-cigarette use. Finally, we tested whether the association between chronic lung disease and susceptibility to e-cigarettes varied by the candidate moderators using tests of interactions. For each test of interaction, we estimated a separate regression model fully adjusted for covariates. A p-value less than .05 was considered statistically significant.

## RESULTS

Individuals with chronic lung disease were more likely to be female, non-Hispanic, Caucasian/White, married, not living with a spouse/partner, older, employed, have a high school degree, earn less than $10,000/year, heterosexual, and smoke cigarettes (Table 1).

Individuals without chronic lung disease were more likely to be female, non-Hispanic, Caucasian /White, married, not living with a spouse/partner, younger, employed, have an undergraduate degree, earn less than $10,000/year, heterosexual, and non-smokers (Table 1).

As shown in Figure 2 and Figure 3, individuals with chronic lung disease were less susceptible to using e-cigarettes than those without chronic lung disease. Among individuals with chronic lung disease, more than half reported exposure to internet advertisements; convenience store, gas station, or supermarket advertisements; TV advertisements for e-cigarettes; or alcohol use. In contrast, less than half of the individuals in this group reported exposure to newspaper advertisements for e-cigarettes, warning labels on e-cigarette packages, others' e-cigarette vapor, and special prices (discounts or coupons) for e-cigarettes; living with someone who uses e-cigarettes; having had a health care provider suggest e-cigarettes; having visited a website or online discussion about e-cigarettes; or cannabis use.

Multivariable modeling revealed that, compared with not having chronic lung disease, having chronic lung disease was associated with a lower likelihood of susceptibility to e-cigarette use (Table 2). Among both groups, viewing a warning label on e-cigarette packages and visiting a website or online discussion about e-cigarettes were associated with an increased likelihood of susceptibility to using e-cigarettes. Among participants without chronic lung disease, exposure to e-cigarette vapor from close contacts, special pricing, living with someone who uses e-cigarettes, and cannabis use were associated with an increased likelihood of susceptibility to e-cigarette use. However, there was no significant interaction between chronic lung disease status and any of the candidate moderators.

## DISCUSSION

Previous research indicates that e-cigarette use is more prevalent among people with chronic lung disease than among those without chronic lung disease,[5, 8] yet the

factors that may influence this discrepancy have not been well studied. The present study investigated the association between chronic lung disease status and susceptibility to using e-cigarettes, the influence of behavioral factors (alcohol use and cannabis use), and exposure to social and environmental factors on this association.

Among our study participants, those who reported not having chronic lung disease were more susceptible to e-cigarette use than those with chronic lung disease, which did not support our hypothesis. This finding does, however, mirror that of our previous study: young individuals who were clinically diagnosed with asthma were less susceptible to using e-cigarettes [40]. However, it contradicts the results of previous national database studies that showed more e-cigarette use among respondents with self-reported chronic lung disease than among those without chronic lung disease [5, 9-11]. A possible explanation for this discrepancy is the difference in analyzing data from patients with self-reported chronic lung disease and examining data from patients who received treatment for chronic lung illness at a health care clinic. Participants in our clinical sample may have received health promotion and counseling to prevent substance use. In addition, they may have presented with chronic lung disease-related symptoms that caused them to avoid any behavior that may provoke their chronic health condition and lead to pulmonary complications. Such individuals may already realize that e-cigarette use has been linked to worsening pulmonary health conditions [41]. Those individuals who participated in the national study may have individuals who had symptoms that did not require clinical visits, thus did not receive g counselling and education concerning e-cigarette use and lung disease.

Contrary to our hypothesis, the strength of the relationship between chronic lung disease and susceptibility to e-cigarette use was not modulated by the presence of any social/environmental or behavioral factors. Moreover, noticing the warning labels on e-cigarette packages was associated with a higher susceptibility to e-cigarette use in individuals regardless of chronic lung disease status. Although perhaps surprising, this result accords with an earlier observation, which showed that noticing warnings on e-cigarette packaging in the past 30 days was most likely linked with higher e-cigarette use [42]. These preliminary findings highlight the need for standardized warning requirements in size, formatting, and content that can help to improve their appearance, recall, and potential impacts, such as those initiated by the European Union's Tobacco Products Directive and the FDA in the United States. As new regulations are implemented, research should be conducted to see if warning exposure varies over time, as previous research with traditional cigarettes has shown that strengthening tobacco warnings is linked with increased warning attention and recall [43, 44]. Furthermore, the use of color or pictures in e-cigarette warnings may improve people's awareness of them as the same is true for other tobacco warnings [45].

In addition, our study demonstrated a positive association between visiting a website or online discussion about e-cigarettes and the susceptibility to using e-cigarettes in individuals regardless of chronic lung disease status. Unger and Bartsch [46] also showed a positive association between visiting tobacco company websites and the susceptibility to using e-cigarettes.

Although we did not detect an association between any of the other behavioral, social, or environmental factors assessed and susceptibility to e-cigarette use in

individuals with chronic lung disease, several factors did associate positively with susceptibility among those without chronic lung disease. Our finding of a positive association between exposure to the e-cigarette vapor of others and susceptibility to using e-cigarettes in individuals without chronic lung disease is consistent with the findings of two previous studies. The first of these studies revealed a positive association between secondhand smoke exposure and susceptibility to smoking in adolescents [47], and the second study found a positive association between secondhand vaping and susceptibility to using e-cigarettes among youth with asthma [48]. Therefore, it is important that people are warned against secondhand vapor exposure to prevent normalizing such behavior (e-cigarette use) [49, 50]. Further, our estimation of 25% of the group with chronic lung disease being exposed to secondhand vaping (SHV) is high and warrants attention. To counter this influence, comprehensive public health efforts should increase their advocacy for clean indoor air laws, vaping-free home and car rules, and other interventions to reduce second-hand vaping exposure among adults. This may contribute to lower susceptibility to using e-cigarettes.

Living with someone who uses e-cigarettes was also associated with a higher susceptibility to e-cigarette use in individuals without chronic lung disease. This finding mirrors that of another study conducted by Ebrahimi Kalan, et al. [51], which found that living with a tobacco/nicotine product user was associated with higher susceptibility to vaping or smoking. Moreover, this study corroborated our finding of no association between living with an e-cigarette user and susceptibility to e-cigarette use among adults with chronic lung disease, as they found no association between e-cigarette use and living with an e-cigarette user among adolescents with asthma [51]. These findings deserve further

investigation since there is evidence that secondhand vaping exacerbates pulmonary conditions [52, 53].

Additionally, exposure to special prices as discounts or coupons for e-cigarettes, vaping devices, or e-liquid and the susceptibility to e-cigarette use was associated with greater susceptibility to e-cigarette use only in individuals without chronic lung disease, even though many participants in both groups reported receiving some form of price reduction or discount. This result underscores that importance of continued monitoring and advocating against the use of price-related promotions to decrease the adoption of e-cigarette use. This finding is consistent with prior research indicating that the odds of using price-related advertisements were significantly higher among individuals who purchased electronic vapor products from a gas station, grocery or drug store, or the internet [54].

Finally, cannabis use was associated with higher susceptibility to e-cigarette use in individuals without chronic lung disease but not in those with chronic lung disease. A previous longitudinal study similarly found a positive association between cannabis use and the likelihood of using e-cigarettes among a large cohort of youth in the United States, but this study did not assess susceptibility in the context of disease status [18].

Overall, this study sheds light on the social, environmental, and behavioral factors that may influence the relationship between chronic lung disease status and susceptibility to e-cigarette use among the adult population in the United States, especially among adults with chronic lung disease. Future longitudinal work is needed to fully understand the temporal relationship between chronic lung disease, behavioral factors, environmental factors, and susceptibility to e-cigarettes. Future study is also needed to explore how the

stability of health conditions or adherence to medications in individuals with chronic lung disease may influence the susceptibility to using e-cigarettes. A future study is also needed to compare the susceptibility of using e-cigarettes among individuals with a confirmed diagnosis of chronic lung disease who have or have not been treated at a medical clinic.

There are several limitations to the current study. First, the study's cross-sectional design restricts causal conclusions; we cannot conclude the temporal relationship between chronic lung disease onset, susceptibility to e-cigarette use, behavioral, social, and environmental factors. Although we accounted for various potential confounding factors, the correlations may have been hidden by response bias, which was not controlled. In addition, we did not evaluate the information on actual e-cigarette use. We only examined the susceptibility to e-cigarette use. Third, we recruited adults with a clinical diagnosis of chronic lung disease (obstructive lung diseases) and we did not include individuals who have other chronic lung diseases such as restrictive lung diseases. Fourth, our sample size was relatively small, which may restrict generalization of our results.

**Conclusion:**

We found that individuals with chronic lung disease are less susceptible to e-cigarette use than are individuals without chronic lung disease. However, we identified no moderators of this relationship. Longitudinal investigations are necessary to test the temporal relationship between chronic lung disease, comorbid substance use, social factors, environmental factors, and susceptibility to using e-cigarettes among individuals with chronic lung disease to prevent lung damage.

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**Table 1. Sociodemographic characteristic of study participants.**

| Variable | Without Chronic Lung Disease (No)<br><br>N = 123<br><br>n (%) | With Chronic Lung Disease<br><br>N = 140<br><br>n (%) | χ2/*P*-value |
|---|---|---|---|
| **Gender** | | | 2.640<br><br>0.267 |
| Female | 56 (45.5) | 72 (51.4) | |
| Male | 54 (43.9) | 50 (35.7) | |
| Other (e.g., transgender) | 1 (.8) | 0 (0) | |
| Missing | 12(9.8) | 18 (12.9) | |
| **Ethnicity - Are you of Hispanic or Latino descent?** | | | 5.911<br><br>0.05* |
| Yes | 10 (8.1) | 3 (2.1) | |
| No | 100 (81.3) | 119 (85.) | |
| Not Sure | 1(.8) | 0 (0) | |
| Missing | 12 (9.8) | 18 (12.9) | |
| **Race** | | | 13.034<br><br>0.034* |
| African American / Black | 19 (15.4) | 29 (20.7) | |
| Asian / Filipino | 7 (5.7) | 2 (1.4) | |
| Pacific Islander / Native Hawaiian | 0(0) | 0 (0) | |
| Caucasian / White | 73 (59.3) | 86 (61.1) | |
| American Indian / Alaskan Native | 0 | 2 (1.4) | |
| More than one ethnic group | 3 (2.4) | 1 (.7) | |
| Not known | 1 (.8) | 0 (0) | |
| Other | 8 (6.5) | 2 (1.4) | |
| Missing | 12 (9.8) | 18 (12.9) | |
| **Current marital status** | | | 15.389<br><br>0.002* |
| Married | 46 (37.4) | 43 (30.7) | |
| Widowed | 2 (1.6) | 6 (4.3) | |
| Divorced, separated | 10 (8.1) | 33 (23.6) | |
| Single, never married | 52 (42.3) | 40 (28.6) | |
| Missing | 12 (10.6) | 18 (12.9) | |

| | | | |
|---|---|---|---|
| **Do you live with a spouse or intimate partner?** | | | |
| Yes | 54 (43.9) | 57 (40.7) | .130 |
| No | 56 (45.5) | 65 (46.4) | .718 |
| Missing | 13(10.6) | 18 (12.9) | |
| **Age (y)** | | | -6.114 |
| Mean (SD) | 35.85 (13.48) | 48.01 (16.69) | <.001* |
| **Occupational status** | | | 39.906 |
| Employed | 48 (39.) | 44 (31.4) | <.001* |
| Unemployed | 18 (14.6) | 30 (21.4) | |
| Retired | 6 (4.9) | 33 (23.6) | |
| Full-time homemaker | 3 (2.4) | 7 (05.) | |
| Student (not employed) | 35 (28.5) | 8 (5.7) | |
| Missing | 13 (10.6) | 18 (12.9) | |
| Highest education level completed | | | 9.764 |
| Less than 12 years | 9 (7.3) | 14 (10.) | .082 |
| High school, GED | 25 (20.3) | 33 (23.6) | |
| A.A., A.S., other vocational program | 11(8.9) | 24 (17.1) | |
| B.A., B.S. etc. | 30 (24.4) | 28 (20.) | |
| M.A., M.S. etc. | 26 (21.1) | 15 (10.7) | |
| Ph.D., M.D., J.D. etc. | 10 (8.1) | 8 (5.7) | |
| Missing | 12 (9.8) | 18 (12.9) | |
| **Income** | | | 9.504 |
| Less than $10,000 | 34 (27.6) | 33(23.6) | .147 |
| $11,000 - $20,000 | 22 (17.9) | 29 (20.7) | |
| $21,000 - $30,000 | 17 (13.8) | 8(5.7) | |

| | | | |
|---|---|---|---|
| $31,000 - $40,000 | 29 (23.6) | 30 (21.4) | |
| $41,000 - $50,000 | 3 (2.4) | 6 (4.3) | |
| $51,000 - $60,000 | 0 | 0 | |
| $61,000 - $70,000 | 3 (2.4) | 6 (4.3) | |
| $71,000 - $80,000 | 3 (2.4) | 10 (7.1) | |
| $81,000 - $90,000 | 0 (0) | 0 (0) | |
| $91,000 - $100,000 | 0 (0) | 0 (0) | |
| Over $100,000 | 0 (0) | 0 (0) | |
| Missing | 12 (9.8) | 18 (12.9) | |
| **Sexual orientation** | | | .769 |
| Homosexual / gay / lesbian | 3 (2.4) | 6 (4.3) | .681 |
| Heterosexual | 100 (81.3) | 109 (77.9) | |
| Bisexual | 7 (5.7) | 7 (5) | |
| Missing | 13 (10.6) | 18 (12.9) | |
| **Lifetime Smoking status** | | | 10.078 |
| No | 61 (49.6) | 43 (30.7) | .002* |
| Yes | 50 (40.7) | 82 (58.6) | |
| Missing | 12 (9.8) | 15 (10.7) | |
| **Current smoking status** | | | 5.283 |
| Every day | 23 (18.7) | 30 (21.4) | .071 |
| Some days | 12 (9.8) | 11 (7.9) | |
| Not at all | 16 (13) | 42 (30.) | |
| Missing | 72 (58.5) | 57 (40.7) | |

*, $p \leq 0.05$

Table 2. Multivariable models of susceptibility to e-cigarette use predicted by environmental factors and behavioral factors, and the interaction (moderation) effects with chronic lung disease with respect to susceptibility to using e-cigarette use.

| Variable | B; (95% CI) | Standard error (SE) | t | OR; (95% CI) | P-value |
|---|---|---|---|---|---|
| Non- chronic lung disease group | .849; (.177, 1.522) | .343 | 2.48 | 2.339; (1.194, 4.579) | .013* |
| chronic lung disease group | -.849; (-1.522, -.178) | .147 | -2.48 | .428; (.218, .837) | .013* |
| | | | | | |
| Exposure to E-Cigarette Internet advertisement in non- chronic lung disease group | 179; (-.756, 1.114) | .477 | .37 | 1.196; (.469, 3.046) | .708 |
| Exposure to E-Cigarette Internet advertisement in chronic lung disease group | .397; (-.564, 1.358) | .491 | .81 | 1.488; (.569, 3.888) | .418 |
| Interaction for chronic lung disease group | -.218; (-1.533, 1.096) | .671 | -.33 | .804; (.216, 2.993) | .745 |
| | | | | | |
| **Exposure to E-Cigarette** newspaper or magazine advertisement in non- chronic lung disease group | -.036; ( -.891, .819) | .436 | -.08 | .964; (.411, 2.268) | .935 |
| **Exposure to E-Cigarette** newspaper or magazine advertisement in chronic lung disease group | .197; (-.704, 1.097) | .459 | .43 | 1.217; (.494, 2.996) | .669 |

| | | | | | |
|---|---|---|---|---|---|
| Interaction for chronic lung disease group | -.232; (-1.490, 1.025) | .642 | -.36 | .793; (.225, 2.789) | .718 |
| | | | | | |
| **Exposure to E-cigarette** convenience store, gas station or supermarket advertisement in non- chronic lung disease group | 1.158; (-.472, 2.789) | .8312 | 1.39 | 3.183; (.623, 16.261) | .164 |
| Exposure to e-cigarette convenience store, gas station or supermarket advertisement in chronic lung disease group | -.0304; (-1.316, 1.255) | .656 | -.05 | .969; (.268, 3.509) | .963 |
| Interaction for chronic lung disease group | 1.188; (-.872, 3.249) | 1.051 | 1.13 | 3.283; (.418, 25.77) | .258 |
| | | | | | |
| Exposure to e-cigarette TV advertisement in non- chronic lung disease | .434; (-.447, 1.315) | .694 | .97 | 1.543; (.639, 3.725) | .334 |
| Exposure to e-cigarette TV advertisement in chronic lung disease | .211; (-.686, 1.108) | .565 | .46 | 1.235; (.503, 3.027) | .645 |
| Interaction for chronic lung disease group | .223; (-1.026,1.473) | .797 | .35 | 1.25; (.358, 4.361) | .726 |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Exposure to e-cigarette warning label in non-chronic lung disease group | 1.732; (.755, 2.709) | .499 | 2.38 | 5.654; (2.126, 15.028) | .001* |
| Exposure to e-cigarette warning label in chronic lung disease group | 1.158; (.204, 2.113) | .487 | 2.38 | 3.186; (1.227, 8.276) | .017* |
| Interaction for chronic lung disease group | .573; (-.805,1.952) | 1.248 | .82 | 1.774; (.447, 7.044) | .415 |
| | | | | | |
| Breathing other's vapor in non- chronic lung disease | 1.044; (.053, 2.034) | .505 | 2.07 | 2.840; (.179, 2.544) | .039* |
| Breathing other's vapor in chronic lung disease | .651; (-.263, 1.565) | .466 | 1.40 | 1.918; (.768, 4.786) | .163 |
| Interaction for chronic lung disease group | .393; (-.934, 1.719) | .677 | .58 | 1.481; (.393, 5.580) | .562 |
| | | | | | |
| Exposure to e-cigarette special pricing in non-chronic lung disease group | 1.327; (.229, 2.434) | .559 | 2.37 | 3.768; (1.258, 11.287) | .018* |
| Exposure to e-cigarette special pricing in chronic lung disease group | .962; (-.069, 1.993) | 1.376 | 1.83 | 2.616; (.933, 7.336) | .067 |
| Interaction for chronic lung disease group | .365; (-1.138, 1.867) | 1.104 | .48 | 1.44; (.321, 6.471) | .634 |

| | | | | | |
|---|---|---|---|---|---|
| Living with someone who uses e-cigarettes in non- chronic lung disease | 1.67; (.189, 3.163) | .759 | 2.21 | 5.347; (1.208, 23.654) | .027* |
| Living with someone who uses e-cigarettes in chronic lung disease | 1.092; (-.395, 2.578) | .759 | 1.44 | 2.979; (.674, 14.209) | .150 |
| Interaction for chronic lung disease group | .585; (-1.484, 2.654) | 1.056 | .55 | 1.794; (.226, 14.209) | .580 |
| | | | | | |
| Visiting website or online discussion about e-cigarettes in non- chronic lung disease | 2.299; (.679, 3.919) | .827 | 2.78 | 9.964; (1.972, 50.350) | .005* |
| Visiting website or online discussion about e-cigarettes in chronic lung disease | 2.636; (.467, .481) | 1.371 | 2.38 | 13.959; (1.595, 122.126) | .017* |
| Interaction for chronic lung disease group | -.337; (-3.025, 2.351) | 1.371 | -.25 | .714; (.0486, 10.492) | .806 |
| | | | | | |
| Alcohol use in non- chronic lung disease | .478; (-.451, 1.407) | .474 | 1.01 | 1.612; (.637, 4.082) | .314 |
| Alcohol use in chronic lung disease group | -.156; (-1.104, .792) | .413 | -.32 | .856; (.332, 2.208) | .747 |
| Interaction in chronic lung disease group | .633; (-.674, 1.941) | 1.257 | .95 | 1.884; (.509, 6.966) | .342 |
| | | | | | |
| Cannabis use in non- chronic lung disease group | 1.772; (.312, 3.232) | .745 | 2.38 | 5.883; (1.367, 25.329) | .017* |

| | | | | | |
|---|---|---|---|---|---|
| Cannabis use in chronic lung disease group | (734; (-.652, 2.119) | .707 | 1.04 | 2.083; .532, 8.328) | .300 |
| Interaction in chronic lung disease group | 1.039; (-.983, 3.059) | 1.031 | 1.01 | 2.825; (.374, 21.321) | .314 |

Models were adjusted for current smoking behavior, age, gender, education, and race
*, $p \leq 0.05$

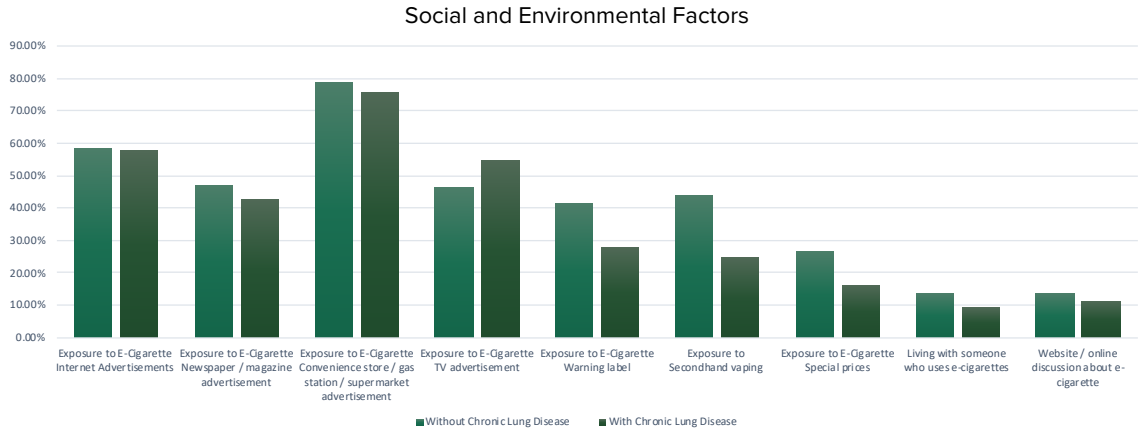


**Figure1. Social and Environmental factors among individuals with and without chronic lung disease.**

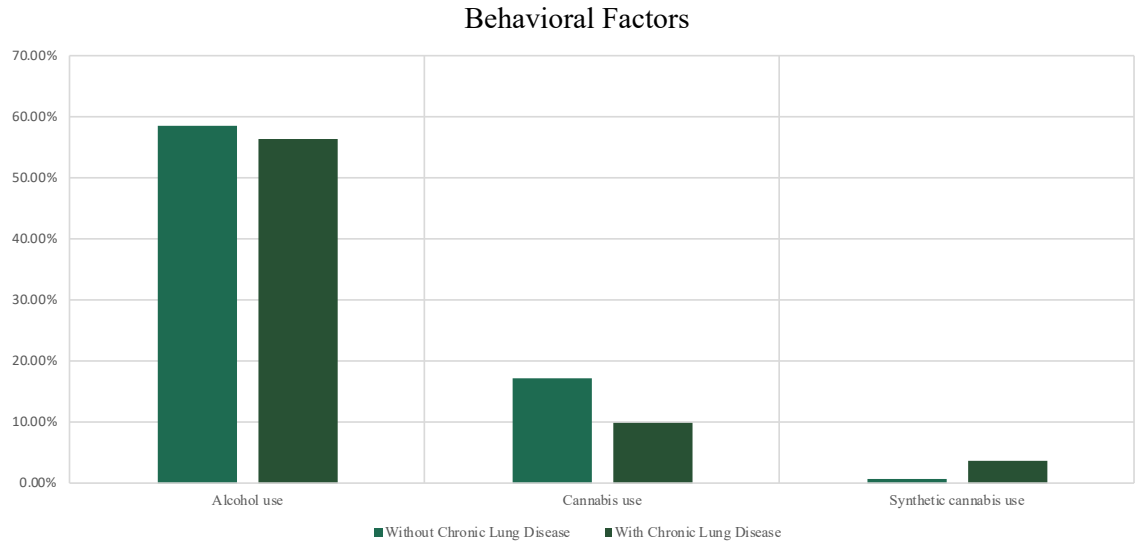


**Figure 2. Social and Environmental factors among individuals with and without chronic lung disease.**

# DISCUSSION AND CONCLUSIONS

In this research project, we examined factors that influenced individuals with chronic lung disease and those without chronic lung disease in increase their susceptibility to using e-cigarettes or actual e-cigarette use. In addition to determining the prevalence of e-cigarette use by individuals with chronic lung disease and those without, this research project investigated psychosocial, physiological, environmental, social, and behavioral factors influence the relationship between chronic lung disease condition and susceptibility to using e-cigarettes or actual e-cigarette use. In this project, we found that e-cigarette use was greater in those with lung disease compared to healthy individuals. This research project also showed that many factors influence the use of e-cigarette in individuals with chronic lung disease including binge drinking, mental health conditions, warning labels, and online e-cigarette discussions.

First, we found that current e-cigarette use is higher among adults with self-reported chronic lung disease than among those without chronic lung disease using nationally representative samples. These findings corroborate with previous research where the prevalence of e-cigarettes was significantly high among adults with chronic lung disease [63, 64]. In comparison, we found that the susceptibility to e-cigarettes was lower among adults with clinically diagnosed chronic lung disease than among those without chronic lung disease. This finding, however, corresponds with our previous work where young adults with clinically diagnosed asthma were less susceptible to using e-cigarettes [65].

Therefore, regulatory actions with the implementation of evidence-based tobacco control interventions to restrict e-cigarette use among adults with chronic lung disease are encouraged to deter e-cigarette use among adults with chronic lung disease. In the first study, we also investigated the influence of binge drinking on the relationship between chronic lung disease and e-cigarette use by analyzing relevant questionnaire items from the national data set. We found that the link between chronic lung disease and e-cigarette use was weaker among more frequent binge drinkers. These findings may be explained by the fact that individuals with chronic lung disease avoided being engaged in e-cigarette use because the pathogenic damage of two unhealthy lung substances (alcohol and e-cigarettes) may exhibit an additive effect, particularly in impairing pathogen clearance from the lungs, increasing inflammation and decreasing immune response, physically damaging epithelial cells, and exacerbating chronic lung diseases (bronchitis, emphysema, and COPD) symptoms.[66]. However, future studies are recommended because there is a lack of research on the long-term impact of e-cigarette use and alcohol use when compared to the number of published studies on the combined impact of traditional smoking and alcohol on the lung [66, 67].

In the second study, we examined if mental health conditions elucidated the relationship between chronic lung disease and e-cigarette use. We also investigated if chronic lung disease and e-cigarette use are conditional on the presence or absence of respiratory symptoms. This study demonstrated that mental health might mediate the association between chronic lung disease and lifetime or current e-cigarette use. These findings were consistent with previous research in which mental health conditions were associated with e-cigarette use [68]. Furthermore, we found that respiratory symptoms did

not affect whether people with chronic lung disease use e-cigarettes. It is possible that just having a chronic lung illness makes a person more likely to use e-cigarettes.

In the third study, we tested the impact of behavioral (alcohol and cannabis use), social (use of an e-cigarette by others in the home and online discussions concerning e-cigarettes) and environmental factors (i.e., advertisements, warning labels, special prices, secondhand e-cigarette vapors, and visiting a website about e-cigarettes) on the relationship between chronic lung disease and the susceptibility to using an e-cigarette. Our analyses did not suggest a statistically significant interaction between chronic lung disease and social, environmental, or behavioral factors on the susceptibility to e-cigarette use. However, we found two significant main effects—noticing e-cigarette warning labels and visiting a website or online discussion about e-cigarettes—were significantly associated with an increased likelihood of susceptibility to using e-cigarettes in both groups. Secondhand e-cigarette vapors, special pricing, cannabis use, and living with someone who uses e-cigarettes were significantly associated with an increased likelihood of susceptibility to e-cigarette use in individuals without chronic lung disease. A previous study found that tobacco companies have leveraged spending on social media campaigns to advertise e-cigarettes as an alternative to cigarette smoking [69]. Additionally, consistent evidence displays the positive impact of environmental and social factors on the susceptibility to using e-cigarettes [47]. Based on these findings, behavior change theories that fully consider social variables, notably the function of social interactions and observational learning may explain our findings[70]. Thus, we recommend implementing robust global policies to restrict e-cigarette marketing, use of enticing flavor solutions, accessibility, and exposure to e-cigarette vapors in public place [71].

## Clinical Implications

Our results may begin helping explain the complex relationship between the likelihood of using e-cigarettes and the various factors we studied. This is a fundamental step for health-care providers (such as pulmonologists and respiratory therapists), researchers, and regulators who want to gain a better understanding of factors that may affect e-cigarette use in individuals with chronic lung disease. Such approaches would contribute to better pulmonary disease management and decreased e-cigarette use and provide a better quality of life for individuals with chronic lung disease. In addition, the findings revealed there is a dire need for more tailored, direct behavioral intervention programs that may prevent e-cigarette use and assist with e-cigarette cessation in this vulnerable population. To restrict e-cigarette exposure among minors, particularly those with chronic lung illnesses, more public health policies and protective measures are needed on a worldwide scale. Our finding may also indicate that health-care providers should screen for e-cigarette use and binge drinking when caring for individuals with chronic lung disease because of the detrimental effects of excessive alcohol intake on lung health. Moreover, our finding suggests that better mental health treatment might lower e-cigarette use among chronic lung disease patients. Clinicians (such as physicians and respiratory therapists) and public health experts should screen for mental health disorders in people with chronic lung disease who use e-cigarettes because mental health conditions can contribute to e-cigarette use and worsen chronic lung disease management. Health-care professionals should be taught to evaluate and refer people with chronic lung disease to mental health professionals.

## Limitations

This study has several limitations. First, the nature of the cross-sectional design did not allow us to conclude the temporal relationship between the variables included in the studies. In addition, the responses were self-reported, which may increase the risk of social desirability bias and other biases. In addition, the chronic lung disease diagnosis pulled from the national data set (BRFSS) was based on a self-reported measure, not a clinical diagnosis measure, which may impair our data's validity. We cannot generalize our findings to individuals with chronic lung disease who live outside of the United States. The relatively small sample sizes in the final studies were also limitations. We were not aware of the frequency or quantity of e-cigarette use in the first and second studies and did not ask about actual e-cigarette use in the third study. Finally, we did not include individuals who have other chronic lung diseases such as restrictive lung disease.

Future Studies

E-cigarette use has a significant impact on public health in both the vulnerable population of individuals with chronic lung disease and the general population because of the complexity of e-cigarette and tobacco behavior and the soaring increase in e-cigarette use [72-75]. Further research with more robust designs are needed to further understand the complex nature of e-cigarette use in both the general and chronic lung disease populations. With the continued study of e-cigarette use, the field will broaden its understanding of a crucial constructs related to the problem of e-cigarette use; ultimately, such understanding would inform the design of more effective prevention and cessation of e-cigarette use programs for individuals with chronic lung disease.

Our study may also provide an impetus for future studies with design interventions that may decrease, stop, and prevent nicotine addiction. Longitudinal and

experimental study designs are recommended to be performed to ascertain the temporality of our proposed models; we want to determine whether e-cigarettes may cause chronic lung disease or whether the incidence of chronic lung disease makes such individuals more susceptible to using e-cigarettes. We encourage researchers to recruit a wide range of individuals who have different chronic lung diseases such as obstructive or restrictive lung disease. Additionally, we recommend explorations into how receiving counseling and education concerning e-cigarette use and lung disease, medication adherence, and clinical visits may influence e-cigarette use among individuals with chronic lung disease. Future studies may investigate all possible interactions of psychoactive drugs and substances, such as pain medications, illegal drugs, and cannabis, that may influence the relationship between having chronic lung disease and being susceptible to using e-cigarettes or actual e-cigarette use. Future studies should look into how environmental and social factors, such as online social networks, family members, physicians, and respiratory therapists, may promote healthy social norms and discourage e-cigarette use, particularly among vulnerable groups such as adults with chronic lung disease.

It is crucial to recognize the characteristics of individuals with/without chronic lung disease who are susceptible to or using e-cigarettes. The current study, ideally, may illuminate the way for the prevention and reduction of tobacco use by identifying the distinct factors surrounding these individuals, and eventually targeting the related risk factors. This may help improve interventions or strategies to reduce adjustable predictors of increased e-cigarette use. Such approaches would contribute to better pulmonary

disease management, decreased e-cigarette use, and provide a better quality of life for both non-chronic/chronic lung disease population.

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# APPENDIX A

# PROJECT INSTITUTIONAL REVIEW BOARD APPROVAL

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
Office of the Institutional Review Board for Human Use

470 Administration Building
701 20th Street South
Birmingham, AL 35294-0104
205.934.3789 | Fax 205.934.1301 |
irb@uab.edu

# APPROVAL LETTER

TO: Alqahtani, Mohammed Mes

FROM: University of Alabama at Birmingham Institutional Review Board
Federalwide Assurance # FWA00005960
IORG Registration # IRB00000196 (IRB 01)
IORG Registration # IRB00000726 (IRB 02)

DATE: 10-Mar-2020

RE: IRB-300003376
Factors that Impact the Relationship Between Pulmonary Status and Susceptibility to Electronic Cigarette Use or Actual Electronic Cigarette Use

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The IRB reviewed and approved the Revision/Amendment submitted on 10-Mar-2020 for the above referenced project. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services.

| | |
|---|---|
| Type of Review: | Expedited |
| Expedited Categories: | 5, 7 |
| **Determination:** | Approved |
| Approval Date: | 10-Mar-2020 |
| **Expiration Date:** | 09-Mar-2023 |

Although annual continuing review is not required for this project, the principal investigator is still responsible for (1) obtaining IRB approval for any modifications before implementing those changes except when necessary to eliminate apparent immediate hazards to the subject, and (2) submitting reportable problems to the IRB. Please see the IRB Guidebook for more information on these topics.

The following apply to this project related to informed consent and/or assent:

- Waiver (Partial) of HIPAA

Documents Included in Review:

- praf.200226.pdf
- pptletter.200310.pdf
- waiverpartial.200310.pdf
- surveyquest.clean.200226.docx

- pptemail.200310.pdf
- pptemail.200310.pdf
- pptletter.200310.pdf

# APPENDIX B

# RESPIRATORY CARE PUBLICATIONS AND PERMISSIONS


## LICENSED CONTENT

| | | | |
|---|---|---|---|
| **Publication Title** | Respiratory care : the official science jo... | **Country** | United States of America |
| **Author/Editor** | American Association for Inhalation Th... | **Rightsholder** | Daedalus Enterprises Inc |
| **Date** | 01/01/2009 | **Publication Type** | e-Journal |
| **Language** | English | **URL** | http://www.rcjournal.com |

## REQUEST DETAILS

| | | | |
|---|---|---|---|
| **Page range(s)** | 20-30 | **Distribution** | Worldwide |
| **Total number of pages** | 30 | **Translation** | Original language of publication |
| **Format (select all that apply)** | Electronic | **Copies for the disabled?** | No |
| **Who will republish the content?** | Publisher, not-for-profit | **Minor editing privileges?** | No |
| **Duration of Use** | Life of current edition | **Incidental promotional use?** | No |
| **Lifetime Unit Quantity** | Up to 1,000,000 | **Currency** | USD |
| **Rights Requested** | Main product | | |

## NEW WORK DETAILS

| | | | |
|---|---|---|---|
| **Title** | Binge Drinking Moderates the Associat... | **Institution name** | University of Alabama at Birmingham (... |
| **Instructor name** | Peter S. Hendricks | **Expected presentation date** | 2022-05-30 |


## GENERAL INFORMATION

| | | | |
|---|---|---|---|
| **Request ID** | 600078161 | **Request Date** | 22 Apr 2022 |
| **Request Status** | Accepted | **Price** | 0.00 USD |

## ALL DETAILS

| | | | |
|---|---|---|---|
| **ISSN:** | 1943-3654 | **Publisher:** | American Association for Respiratory ... |
| **Type of Use:** | Republish in a thesis/dissertation | **Portion:** | Chapter/article |

## LICENSED CONTENT

| | | | |
|---|---|---|---|
| **Publication Title** | Respiratory care | **Country** | United States of America |
| **Article Title** | The Influence of Mental Health and Re... | **Rightsholder** | Daedalus Enterprises Inc |
| **Author/Editor** | American Association for Inhalation Th... | **Publication Type** | e-Journal |
| **Date** | 01/01/2009 | **URL** | http://www.rcjournal.com |
| **Language** | English | **Start Page** | respcare.09579 |

## REQUEST DETAILS

# APPENDIX C

## CONSENT FORMED AND QUESTIONNAIRS

CONSENT FORM TO BE PART OF A RESEARCH STUDY

TITLE OF RESEARCH: Factors that Impact the Relationship between Pulmonary Status and Susceptibility to Electronic Cigarette Use or Actual Electronic Cigarette Use

UAB IRB PROTOCOL NUMBER: IRB-300003376

PRINCIPAL INVESTIGATOR: Mohammed M. Alqahtani, MSs, RRT-NPS, CTTS

SPONSOR: UAB School of Health Professions, Department of Physical Therapy and Occupational Therapy

General Information

You are being asked to take part in a research study. This research study is voluntary, meaning you do not have to take part in it. The procedures, risks, and benefits are fully described further in the consent form.

Purpose

The purpose of the study is to explores various psychosocial, physiological, intrapersonal, behavioral, and environmental factors that may affect the association between pulmonary status and electronic cigarette (e-cigarettes) use.

Duration & Visits

There will be one-time visit where you can may asked to complete self-report questionnaires that should take between 20-25 minutes.

There is also a follow-up 5 minutes call with six months after today.

Overview of Procedures

You are being asked to participate in self-report questionnaires that should take between 20-25 minutes. You will be asked questions related to smoking history, e-cigarette use, psychosocial factors, behavioral factors, environmental factors, and intrapersonal factors.

There is also an option of taking a web-based survey, Qualtrics® (Qualtrics, Provo, UT), if you do not have enough time to complete the surveys at this time. The online version of the questionnaires will be sent to the one week from now.

There is also a follow-up 5 minutes call with 6 months after today to follow-up with any change regarding to e-cigarette use.

Risks

There is a risk of breach of confidentiality, but All data will be stored on password-protected computers with access limited to the investigators of this study to maximize the confidentiality. It is expected that there will not be any physical or emotional harm to participants. Participants will have the right to withdraw from the study at any time. You also can take a break from the survey if you become tired.

Benefits

You may not benefit from participating in this research. However, the findings of this research project will unmask different factors that may be associated with the e-cigarette use. Different recommendations will be suggested at the end of this study.

Alternatives

The alternative is not to enroll in this study.

Purpose of the Research

You are invited to participate in a research study that explores various factors that may affect the association between pulmonary status and electronic cigarette (e-cigarettes) use. This study will aid in decreasing, stopping, and preventing nicotine addiction. You are invited to participate in this study because you are either diagnosed with any of the

pulmonary disease or reported healthy wellbeing. The total number of participants that are needed in this study is 500 individuals.

Explanation of the Procedures

You are being asked to participate in self-report questionnaires that should take between 20-25 minutes. You will be asked questions related to smoking history, e-cigarette use, psychosocial factors, behavioral factors, environmental factors, and intrapersonal factors. We would have a follow-up of 5 minutes call 6 months after today to follow-up with any change regarding to e-cigarette use. The researchers will keep these documents in a locked filing cabinet in the office of the Rehabilitation Science Department. They will only be used by the researchers directly involved in this study.

Risks and Discomforts

It is expected that there will not be any physical or emotional harm to participants. Participants will have the right to withdraw from the study at any time. You also can take a break from the survey if you become tired. You also have the right to skip any question that you are not comfortable with. There is a risk of breach of confidentiality, but all data will be stored on password-protected computers with access limited to the investigators of this study to maximize the confidentiality.

Benefits

You may not benefit from participating in this research. However, the findings of this research project will unmask different factors that may be associated with the e-cigarette use. Different recommendations will be suggested at the end of this study. This study may help us better understand the nature of e-cigarette use. If you take part in this study, you may help others in the future.

Alternatives

The alternative is not to enroll in this study.

Confidentiality and Authorization to Use and Disclose Information for Research Purposes

Federal regulations give you certain rights related to your health information. These include the right to know who will be able to get the information and why they may be able to get it. The study doctor must get your authorization (permission) to use or give out any health information that might identify you.

What protected health information may be used and/or given to others?

All medical information, including but not limited to information and/or records of any diagnosis or treatment of disease or condition, which may include sexually transmitted diseases (e.g., HIV, etc.) or communicable diseases, drug/alcohol dependency, etc.; all personal identifiers, including but not limited to your name, social security number, medical record number, date of birth, dates of service, etc.; any past, present, and future history, examinations, laboratory results, imaging studies and reports and treatments of any kind, including but not limited to drug/alcohol treatment, psychiatric/psychological treatment; financial/billing information, including but not limited to copies of your medical bills; any other information related to or collected for use in the research study, regardless of whether the information was collected for research or non-research (e.g., treatment) purposes; records about any study drug you received or about study devices used; and consent forms from past studies that might be in your medical record.

Who may use and give out information about you?

Information about your health may be used and given to others by the study doctor and staff. They might see the research information during and after the study.

Who might get this information?

All Individuals/entities listed in the informed consent document(s), including but not limited to, the physicians, nurses and staff and others performing services related to the research (whether at UAB or elsewhere). Your information may also be given to the sponsor of this research.

Information about you and your health which might identify you may be given to:

· the Office for Human Research Protections (OHRP)

· the University of Alabama at Birmingham - the physicians, nurses and staff working on the research study (whether at UAB or elsewhere); other operating units of UAB, UAB Hospital, UAB Highlands Hospital, University of Alabama Health Services Foundation, as necessary for their operations; the UAB IRB and its staff

· the billing offices of UAB and UAB Health Systems affiliates and its billing agents

Why will this information be used and/or given to others?

Information about you and your health that might identify you may be given to others to carry out the research study. The sponsor will analyze and evaluate the results of the study. In addition, people from the sponsor and its consultants will be visiting the research site. They will follow how the study is done, and they will be reviewing your information for this purpose.

What if I decide not to give permission to use and give out my health information?

By signing this consent form, you are giving permission to use and give out the health information listed above for the purposes described above. If you refuse to give permission, you will not be able to be in this research.

Why will this information be used and/or given to others?

Information about you and your health that might identify you may be given to others to carry out the research study. The sponsor will analyze and evaluate the results of the study. In addition, people from the sponsor and its consultants will be visiting the research site. They will follow how the study is done, and they will be reviewing your information for this purpose.

What if I decide not to give permission to use and give out my health information?

By signing this consent form, you are giving permission to use and give out the health information listed above for the purposes described above. If you refuse to give permission, you will not be able to be in this research.

May I review or copy the information obtained from me or created about me?

You have the right to review and copy your health information. However, if you decide to be in this study and sign this permission form, you will not be allowed to look at or copy your information until after the research is completed.

May I withdraw or revoke (cancel) my permission?

Yes, but this permission will not stop automatically. The use of your personal health information will continue until you cancel your permission.

You may withdraw or take away your permission to use and disclose your health information at any time. You do this by sending written notice to the study doctor. If you withdraw your permission, you will not be able to continue being in this study.

When you withdraw your permission, no new health information which might identify you will be gathered after that date. Information that has already been gathered may still

be used and given to others. This would be done if it were necessary for the research to be reliable.

Is my health information protected after it has been given to others?

If you give permission to give your identifiable health information to a person or business, the information may no longer be protected. There is a risk that your information will be released to others. Including others outside of UAB, without your permission.

Voluntary Participation and Withdrawal

Whether or not you take part in this study is your choice. There will be no penalty if you decide not to be in the study. If you decide not to be in the study, you will not lose any benefits you are otherwise owed. You are free to withdraw from this research study at any time. Your choice to leave the study will not affect your relationship with this institution.

If you are uncomfortable about completing the survey, you may withdraw at any time or simply submit a blank survey. The researcher will ask if the information already collected from you can be used. If you are a UAB student or employee, taking part in this research is not a part of your UAB class work or duties. You can refuse to enroll, or withdraw after enrolling at any time before the study is over, with no effect on your class standing, grades, or job at UAB. You will not be offered or receive any special consideration if you take part in this research.

Cost of Participation

There are no costs to you to be in this study.

Payment for Participation in Research

Participants will be compensated financially for their time. You will receive $15 upon participation in the study. Ask the study staff about the method of payment that will be used for this study (e.g., check, cash, gift card, direct deposit).

Questions

If you have any questions, concerns, or complaints about the research, please contact Mr. Alqahtani. He will be glad to answer any of your questions. Mr. Alqahtani's number is (404) 464-6729.If you have questions about your rights as a research participant, or concerns or complaints about the research, you may contact the UAB Office of the IRB (OIRB) at (205) 934-3789 or toll free at 1-855-860-3789 or irb@uab.edu. Regular hours for the OIRB are 8:00 a.m. to 5:00 p.m. CT, Monday through Friday.

Legal Rights

You are not waiving any of your legal rights by signing this consent form.

## Part One

Please read each statement and circle a number 0, 1, 2 or 3 that indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

**The rating scale is as follows:**
0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

| | | | | |
|---|---|---|---|---|
| 1. I found it hard to wind down | 0 | 1 | 2 | 3 |
| 2. I was aware of dryness of my mouth | 0 | 1 | 2 | 3 |
| 3. I couldn't seem to experience any positive feeling at all | 0 | 1 | 2 | 3 |
| 4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion) | 0 | 1 | 2 | 3 |
| 5. I found it difficult to work up the initiative to do things | 0 | 1 | 2 | 3 |
| 6. I tended to over-react to situations | 0 | 1 | 2 | 3 |
| 7. I experienced trembling (eg, in the hands) | 0 | 1 | 2 | 3 |
| 8. I felt that I was using a lot of nervous energy | 0 | 1 | 2 | 3 |
| 9. I was worried about situations in which I might panic and make a fool of myself | 0 | 1 | 2 | 3 |
| 10. I felt that I had nothing to look forward to | 0 | 1 | 2 | 3 |
| 11. I found myself getting agitated | 0 | 1 | 2 | 3 |
| 12. I found it difficult to relax | 0 | 1 | 2 | 3 |
| 13. I felt down hearted and blue | 0 | 1 | 2 | 3 |
| 14. I was intolerant of anything that kept me from getting on with what I was doing | 0 | 1 | 2 | 3 |
| 15. I felt I was close to panic | 0 | 1 | 2 | 3 |
| 16. I was unable to become enthusiastic about anything | 0 | 1 | 2 | 3 |
| 17. I felt I wasn't worth much as a person | 0 | 1 | 2 | 3 |
| 18. I felt that I was rather touchy | 0 | 1 | 2 | 3 |
| 19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat) | 0 | 1 | 2 | 3 |
| 20. I felt scared without any good reason | 0 | 1 | 2 | 3 |
| 21. I felt that life was meaningless | 0 | 1 | 2 | 3 |

## Part One

Please read each statement and circle a number 0, 1, 2 or 3 that indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

**The rating scale is as follows:**
0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

| | | | | |
|---|---|---|---|---|
| 1. I found it hard to wind down | 0 | 1 | 2 | 3 |
| 2. I was aware of dryness of my mouth | 0 | 1 | 2 | 3 |
| 3. I couldn't seem to experience any positive feeling at all | 0 | 1 | 2 | 3 |
| 4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion) | 0 | 1 | 2 | 3 |
| 5. I found it difficult to work up the initiative to do things | 0 | 1 | 2 | 3 |
| 6. I tended to over-react to situations | 0 | 1 | 2 | 3 |
| 7. I experienced trembling (eg, in the hands) | 0 | 1 | 2 | 3 |
| 8. I felt that I was using a lot of nervous energy | 0 | 1 | 2 | 3 |
| 9. I was worried about situations in which I might panic and make a fool of myself | 0 | 1 | 2 | 3 |
| 10. I felt that I had nothing to look forward to | 0 | 1 | 2 | 3 |
| 11. I found myself getting agitated | 0 | 1 | 2 | 3 |
| 12. I found it difficult to relax | 0 | 1 | 2 | 3 |
| 13. I felt down hearted and blue | 0 | 1 | 2 | 3 |
| 14. I was intolerant of anything that kept me from getting on with what I was doing | 0 | 1 | 2 | 3 |
| 15. I felt I was close to panic | 0 | 1 | 2 | 3 |
| 16. I was unable to become enthusiastic about anything | 0 | 1 | 2 | 3 |
| 17. I felt I wasn't worth much as a person | 0 | 1 | 2 | 3 |
| 18. I felt that I was rather touchy | 0 | 1 | 2 | 3 |
| 19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat) | 0 | 1 | 2 | 3 |
| 20. I felt scared without any good reason | 0 | 1 | 2 | 3 |
| 21. I felt that life was meaningless | 0 | 1 | 2 | 3 |

**Part One**

Below are a number of statements that describe ways in which people act and think. For each statement, please indicate how much you agree or disagree with the statement.

If you Agree strongly circle 1.
If you agree Somewhat circle 2.
If you Disagree somewhat circle 3.
If you Disagree Strongly circle 4.

Be sure to indicate your agreement or disagreement for every statement below.

| | Agree Strongly | Agree Some | Disagree Some | Disagree Strongly |
|---|---|---|---|---|
| 1. I generally like to see things through to the end. | | | | |
| 2. My thinking is usually careful and purposeful. | | | | |
| 3. When I am in great mood, I tend to get into situations that could cause me problems. | | | | |
| 4. Unfinished tasks really bother me. | | | | |
| 5. I like to stop and think things over before I do them. | | | | |
| 6. When I feel bad, I will often do things I later regret in order to make myself feel better now. | | | | |
| 7. Once I get going on something I hate to stop. | | | | |
| 8. Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse. | | | | |
| 9. I quite enjoy taking risks. | | | | |
| 10. I tend to lose control when I am in a great mood. | | | | |
| 11. I finish what I start. | | | | |
| 12. I tend to value and follow a rational, "sensible" approach to things. | | | | |
| 13. When I am upset, I often act without thinking. | | | | |
| 14. I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional | | | | |
| 15. When I feel rejected, I will often say things that I later regret. | | | | |
| 16. I would like to learn to fly an airplane. | | | | |
| 17. Others are shocked or worried about the things I do when I am feeling very excited. | | | | |
| 18. I would enjoy the sensation of skiing very fast down a high mountain slope. | | | | |
| 19. I usually think carefully before doing anything. | | | | |
| 20. I tend to act without thinking when I am really excited | | | | |

AWESOME!! Thanks for sticking with us! Keep going

## Part Two

**Instructions**: This questionnaire is designed to assess beliefs people have about the consequences of smoking an e-cigarette. We are interested in your general expectations about the consequences of your smoking an e-cigarette. Below is a list of statements. Each statement contains a possible consequence of smoking an e-cigarette. For each of the statements listed below, please rate how LIKELY or UNLIKELY you believe each consequence is for you when you smoke an e-cigarette. If the consequence seems LIKELY to you, circle a number from 5-9. That is, if you believe that a consequence would never happen, circle 0; if you believe a consequence would happen every time you smoke, circle 9. If it seems a little unlikely to you, you would circle 4.

**0** Completely Extremely **1** Very **2** Somewhat **3** A little **4** A little **5** Somewhat **6** Very **7** Extremely **8** Completely **9**

□----------**UNLIKELY**----------X----------**LIKELY**----------□

| | **UNLIKELY** ⟶ **LIKELY** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. My throat burns after smoking an e-cigarette. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 2. I enjoy the taste sensations while smoking an e-cigarette | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3. Nicotine "fits" can be controlled by smoking an e-cigarette. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 4. When I'm angry, an e-cigarette can calm me down. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 5. When I'm alone, an e-cigarette can help me pass the time | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 6. Smoking an e-cigarette energizes me. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 7. Smoking an e-cigarette calms me down when I feel nervous. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 8. An e-cigarette can give me energy when I'm bored and tired | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 9. I will enjoy the flavor of an e-cigarette. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10. If I have nothing to do, an e-cigarette can help kill time. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 11. When I smoke an e-cigarette, the taste is pleasant. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 12. Smoking an e-cigarette will satisfy my nicotine cravings. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 13. I feel like part of a group when I'm around other e-cigarette smokers. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 14. Smoking an e-cigarette makes me seem less attractive | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 15. By smoking e-cigarettes, I risk heart disease and lung cancer. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 16. Smoking an e-cigarette helps me enjoy people more. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 17. People think less of me if they see me smoking an e-cigarette. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 18. If I'm feeling irritable, an e-cigarette will help me relax. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 19. Smoking an e-cigarette irritates my mouth and throat. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 20. Smoking an e-cigarette helps me control my weight. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 21. The more I smoke e-cigarettes, the more I risk my health. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 22. E-cigarettes keep me from eating more than I should. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 23. Smoking e-cigarettes keeps my weight down. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 24. I look ridiculous while smoking an e-cigarette | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 25. I feel more at ease with other people if I have an e-cigarette | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

**Part Two**

**Please indicate your agreement with the following statements.**

| Tobacco/E-cigarette Perceptions | Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| E-cigarettes contain nicotine | | | | | |
| E-cigarettes can help quit regular cigarette use | | | | | |
| E-cigarettes are less harmful than regular cigarettes | | | | | |
| E-cigarettes can help reduce regular cigarette use | | | | | |
| E-cigarettes can be used in non-smoking environments | | | | | |
| E-cigarettes are less addictive than regular cigarettes | | | | | |

**Please rate each item from 1 (strongly disagree) to 5 (strongly agree).**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Electronic cigarettes can be used to quit or cut down on smoking traditional cigarettes | | | | | |
| 2. Electronic cigarettes are less expensive than traditional cigarettes | | | | | |
| 3. Electronic cigarettes are more convenient or easier to use than traditional cigarettes | | | | | |
| 4. Electronic cigarettes are more enjoyable to use than traditional cigarettes | | | | | |
| 5. Electronic cigarettes are more socially acceptable to use than smoking traditional cigarettes | | | | | |
| 6. Electronic cigarettes are less harmful to the user's health than traditional cigarettes | | | | | |
| 7. Electronic cigarettes are less harmful to the health of those in close proximity to the user than traditional cigarettes | | | | | |
| 8. Compared to traditional cigarettes, electronic cigarettes can improve health | | | | | |
| 9. Using electronic cigarettes, compared to traditional cigarettes, can improve my general sense of smell | | | | | |
| 10. Using electronic cigarettes, compared to traditional cigarettes, can improve my sense of taste | | | | | |

**Part Three**

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Answer each question by choosing just one answer. If you are unsure how to answer a question, please give the best answer you can

1) In general, would you say your health is
   □1 Excellent □2Very good □3 Good □4 Fair □5 Poor

**The following questions are about activities you might do during a typical day. Does <u>your health now</u> <u>limit you</u> in these activities? If so, how much?**

| | Yes, Limited a lot | Yes, Limited a little | No, Not at all limited |
|---|---|---|---|
| Moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf. | | | |
| Climbing several flights of stairs | | | |

2) During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

| | Yes | No |
|---|---|---|
| Accomplished less than you would like. | | |
| Were limited in the **kind** of work or other activities. | | |

3) During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

| | Yes | No |
|---|---|---|
| Accomplished less than you would like. | | |
| Did work or activities **less carefully than usual**. | | |

4) During the past 4 weeks, how much did pain interfere with your normal work (including work outside the home and housework)?
   □ Not at all □ A little bit □ Moderately □ Quite a bit □ extremely

5) How much of the time during the past 4 weeks…

| | All of the time | Most of the time | A good bit of the time | Some of the time | A little of the time | None of the time |
|---|---|---|---|---|---|---|
| Have you felt calm & peaceful? | | | | | | |
| Did you have a lot of energy? | | | | | | |
| Have you felt down hearted and blue? | | | | | | |

6) During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?
   □All of the time □Most of the time □Some of the time □A little of the time □5None of the time

**Part Three**

| On how many days of the past 7 days | 0 days | 1-2 days | 3-5 days | 6-7 days |
|---|---|---|---|---|
| 1) Have you been deliberately trying to limit the amount of food you eat to influence your weight or shape (whether or not you have succeeded)? | | | | |
| 2) Have you gone for long periods of time (e.g., 8 or more waking hours) without eating anything at all in order to influence your weight or shape | | | | |
| 3) Has thinking about food, eating or calories made it very difficult to concentrate on things you are interested in (such as working, following a conversation or reading)? | | | | |
| 4) Has thinking about your weight or shape made it very difficult to concentrate on things you are interested in (such as working, following a conversation or reading)? | | | | |
| 5) Have you had a definite fear that you might gain weight? | | | | |
| 6) Have you had a strong desire to lose weight? | | | | |
| 7) Have you tried to control your weight or shape by making yourself sick (vomit) or taking laxatives? | | | | |
| 8) Have you exercised in a driven or compulsive way as a means of controlling your weight, shape or body fat, or to burn off calories? | | | | |
| 9) Have you had a sense of having lost control over your eating (at the time that you were eating)? | | | | |
| 10) On how many of these days (i.e. days on which you had a sense of having lost control over your eating) did you eat what other people would regard as an unusually large amount of food in one go? | | | | |

| **On how many days of the past 7 days** | **Not at all** | **Slightly** | **Moderately** | **Markedly** |
|---|---|---|---|---|
| 11) Has your weight or shape influenced how you think about (judge) yourself as a person? | | | | |
| 12) How dissatisfied have you been with your weight or shape? | | | | |

## Part Three

**Please choose the one best response to describe your shortness of breath. Grade**

0 "I only get breathless with strenuous exercise"

1 "I get short of breath when hurrying on the level or walking up a slight hill"

2 "I walk slower than people of the same age on the level because of breathlessness or have to stop for breath when walking at my own pace on the level"

3 "I stop for breath after walking about 100 yards or after a few minutes on the level"

4 "I am too breathless to leave the house" or "I am breathless when dressing"

Grade.....

1) **How frequently are you coughing today?**

□ None: unaware of coughing

□ Rare: cough now and then

□ Occasional: less than hourly

□ Frequent: one or more times an hour

□ Almost constant: never free of cough or feeling free of the need to cough

2) **How frequently were you coughing last night?**

□None: unaware of coughing

□Rare: cough in the morning, but I don't waken from sleep

□Occasional: wake a few times but I fall back asleep right away

□Frequent: waken many times through the night with fits of coughing

□Almost constant: up all night with coughing

3) **How severe were your coughing episodes on a typical day during the past week?**

□None: unaware of coughing1

□Mild: did not interfere with usual morning or daily activity

□Moderate: must stop activity during coughing episode

□Marked: must stop activity during and for a brief period after coughing episode

□Severe: stops all activity for some time and is exhausting; can be accompanied by dizziness, headache or pain

4) **How easy is it to cough up sputum when you cough today?**

□None: unaware of coughing at all1

□Easy: sputum comes up without difficulty after only one or two coughs2

□Somewhat difficult: most of the sputum comes up but only after several hard coughs3

□Very difficult: some sputum comes up after hard coughing but there is the feeling that most is still sticking down there4
□Impossible: there is sputum down there but no matter how hard the coughing nothing comes up

5) **How much chest tightness or discomfort do you have today?**
□None: unaware of any discomfort
□Mild: noticeable now-and-then but is not bothersome and passes quickly; does not limit activity
□Moderate: noticeable during light activity such as walking one block or up one flight of stairs

☐Marked: noticeable while washing or dressing in the morning
☐Severe: almost constant and limits all activity; present even while resting

**Great. Thank completing these you for questions!**

**Part Four**

Answer each question by choosing just one answer. If you are unsure how to answer a question, please give the best answer you can

| | | | | | |
|---|---|---|---|---|---|
| 1. How often do you have a drink containing alcohol? | ☐ Never | ☐ Monthly or less | ☐ Two to four times a month | ☐ Two to three times a week | ☐ Four or more times a week |
| How often do you have six or more drinks on one occasion? | ☐ Never | ☐ Monthly or less | ☐ Monthly or less | ☐ Monthly or less | ☐ Monthly or less |
| How many drinks containing alcohol do you have on a typical day when you are drinking? (1 drink = 12 oz. beer, 4 oz. wine or 1.5 oz. distilled spirits)? | ☐ 1 or 2 | ☐ 3 or 4 | ☐ 5 or 6 | ☐ 7 to 9 | ☐ 10 or more |

**Other drugs:**

| **How often do you use the following?** | **Never** | **Monthly or less** | **Two to four times a month** | **Two to three times a week** | **Four or more times a week** |
|---|---|---|---|---|---|
| Cannabis: (Marijuana, pot, weed, grass, hash, reefer, or bud) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Opiates (e.g., heroin, morphine, etc.)? | ☐ | ☐ | ☐ | ☐ | ☐ |
| Hallucinogens (e.g., LSD PCP) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Major stimulants (e.g., amphetamine Methamphetamine, cocaine, crack, Rock, Base, Snort, Crystal, Crank, Ice.)? | ☐ | ☐ | ☐ | ☐ | ☐ |
| Barbiturates or other sedatives | ☐ | ☐ | ☐ | ☐ | ☐ |
| Nitrous oxide | ☐ | ☐ | ☐ | ☐ | ☐ |
| Inhalants (airplane glue, gasoline, amyl nitrate, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Bath salts: (Bloom, Cloud Nine, Cosmic Blast, Flakka). | ☐ | ☐ | ☐ | ☐ | ☐ |
| MDMA: (Ecstasy, Molly) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Dissociatives: (ketamine, phencyclidine (PCP), dextromethorphan (DXM). | ☐ | ☐ | ☐ | ☐ | ☐ |
| Synthetic Cannabis: (K2, Spice). | ☐ | ☐ | ☐ | ☐ | ☐ |
| Psychedelics: (Psilocybin, Magic Mushrooms, Shrooms, Purple Passion, Acid, 2C-B, 2C-B, 2C-E, 2C-I, 25i-NBOMe). | ☐ | ☐ | ☐ | ☐ | ☐ |
| Barbiturates and Benzodiazepines: (Quaaludes, Downers, Ludes, Xanax, Niravam, Bars, Handlebars) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Non-prescription stimulant Use: (Ritalin, Adderall, Dexedrine, concerta) | ☐ | ☐ | ☐ | ☐ | ☐ |

## Part Four

Answer each question by choosing just one answer. If you are unsure how to answer a question, please give the best answer you can

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **When you are using the Internet, how often do you see ads or promotions for e-cigarettes?** | I do not use the Internet | Never | Rarely | Sometimes | Most of the time | Always | |
| **When you read newspapers or magazines, how often do you see ads or promotions for e-cigarettes?** | I do not read newspapers or magazines | Never | Rarely | Sometimes | Most of the time | Always | |
| **When you go to a convenience store, supermarket, or gas station, how often do you see ads or promotions for e-cigarettes?** | I never go to a convenience store, supermarket, or gas station | Never | Rarely | Sometimes | Most of the time | Always | |
| **When you watch TV, how often do you see ads or promotions for e-cigarettes?** | I do not watch TV or go to the movies | Never | Rarely | Sometimes | Most of the time | Always | |
| **During the past 30 days, how often did you see a warning label on an e-cigarette package?** | I did not see an e-cigarette package during the past 30 days | Never | Rarely | Sometimes | Most of the time | Always | |
| **During the past 30 days, on how many days did you breathe the vapor from someone who was using an e-cigarette in an indoor or outdoor public place? Examples of indoor public places are school buildings, stores, restaurants, and sports arenas. Examples of outdoor public places are school grounds, parking lots, stadiums, and parks.** | 0 days | 1 or 2 days | 3 to 5 days | 6 to 9 days | 10 to 19 days | 20 to 29 days | All 30 days |
| **In the last 30 days, have you noticed any special price offers, such as discounts or coupons, for e-cigarettes/vaping devices or e-liquid?** | Yes | | | No | | | |
| **Does anyone who lives with you use e-cigarette?** | Yes | | | No | | | |
| **Has a healthcare provider suggested electronic cigarettes to you?** | Yes | | | No | | | |

**Part Four**

**Please rate each item from 1 (Not at all likely) to 10 (Very likely).**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| How likely are you to use an electronic cigarette? | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Please rate each item from 1 (Not at all likely) to 5 (Very likely).**

| E-Cigarette Susceptibility | Definitely yes | Probably yes | Probably not | Definitely not |
|---|---|---|---|---|
| Do you think that you will use an e-cigarette soon? | | | | |
| Do you think that in the future you might experiment with e-cigarettes? Would you say. | | | | |
| Do you think you will use an e-cigarette in the next year? Would you say. . . | | | | |
| If one of your best friends were to offer you an e-cigarette, would you smoke it? Would you say | | | | |

**Part Five**

1. **Have you ever used an electronic cigarette?**

0 = No (Please skip to the next section Part Six).
1 = Yes

2. **In the past 30 days, have you used an electronic cigarette (also called e-cigarette)?**

0 = No
1 = Yes

3. **In the past 30 days, on how many days how many days did you use an electronic cigarette?** (1-30)

--------- (number of days).

4. **On the days you used an electronic cigarette, how many puffs per day did you take?**

5. **What is the main reason you use, or have you used electronic cigarettes?**

1- To help quit smoking cigarette.
2- Have something in non-smoking area.
3- Use as less risky product long term.

6. **How would you describe your use of the electronic cigarette?**

1 = Experimental.
2 = Occasional.
3 = Regular.

7. **What kind of electronic cigarette do you usually use with respect to nicotine level?**

1 = Nicotine Free.
2 = Low nicotine.
3 = Regular nicotine.
4 = Use multiple kinds.

8. **What kind of electronic cigarette do you usually use with respect to flavor?**

1 = Regular tobacco flavor.
2 = Menthol.
3 = Other like fruit, chocolate, wine.
4 = More than one kind listed above.

9. **How often do you use electronic cigarette compared to regular cigarette?**

1 = A lot less than regular cigarette.
2 = A little less than regular cigarette.
3 = About the same as regular cigarette.
4 = A little more than regular cigarette.
5 = A lot more than regular cigarettes.

10. **How long does an electronic cartridge last for you?**

--------- (number of days).

11. **How many times per day do you usually use your electronic cigarette? (Assume that one "time" consists of around 15 puffs or lasts around 10 minutes)**

| | | | | | |
|---|---|---|---|---|---|
| 0-4 | 5-9 | 10 -14 | 15 -19 | 20 – 29 | 30+ |

| | | | | | |
|---|---|---|---|---|---|
| Times | Times | Times | Times | Times | Times |

**12. On days that you can use your electronic cigarette freely, how soon after you wake up do you first use your electronic cigarette?**

| | | | | | |
|---|---|---|---|---|---|
| 0 – 5 Minutes | 6 – 15 Minutes | 16 – 30 Minutes | 31 – 60 Minutes | 61 – 120 Minutes | 121+ Minutes |

**13. Do you sometimes awaken at night to use your electronic cigarette?**

| | |
|---|---|
| Yes | No |

**14. If yes, how many nights per week do you typically awaken to use your electronic cigarette?**

| | | |
|---|---|---|
| 0 -1 Nights | 2 -3 Nights | 4+ Nights |

**15. Do you use an electronic cigarette now because it is really hard to quit?**

| | |
|---|---|
| Yes | No |

**16. Do you ever have strong cravings to use an electronic cigarette?**

| | |
|---|---|
| Yes | No |

**17. Over the past week, how strong have the urges to use an electronic cigarette been?**

| | | |
|---|---|---|
| None/Slight | Moderate/Strong | Very Strong/Extremely Strong |

**18. Is it hard to keep from using an electronic cigarette in places where you are not supposed to?**

| | |
|---|---|
| Yes | No |

**When you haven't used an electronic cigarette for a while or when you tried to stop using…**

**19. Did you feel more irritable because you couldn't use an electronic cigarette?**

| | |
|---|---|
| Yes | No |

**20. Did you feel nervous, restless, or anxious because you couldn't use an electronic cigarette?**

| | |
|---|---|
| Yes | No |

**Part Six**

1. **Have you smoked at least 100 cigarettes in your entire life?**

1 Yes
2 No [GO TO DEMOGRAPHIC SECTION PART SEVEN]

2. **Do you now smoke cigarettes every day, some days, or not at all?**

1 Every day
2 Some days
3 Not at all [GO TO Demographic section]

3. **During the past 12 months, have you stopped smoking for one day or longer because you were trying to quit smoking?**
   - Yes
   - No
4. **How long has it been since you last smoked a cigarette, even one or two puffs?**
   - Within the past month (less than 1 month ago)
   - Within the past 3 months (1 month but less than 3 months ago)
   - Within the past 6 months (3 months but less than 6 months ago)
   - Within the past year (6 months but less than 1 year ago)
   - Within the past 5 years (1 year but less than 5 years ago)
   - Within the past 10 years (5 years but less than 10 years ago)
   - 10 years or more
   - Never smoked regular

5. **What is your desire to quit smoking?** (Scale of 1 to 10 with 1 = No desire to quit and 10 = full desire to quit).
   0 1 2 3 4 5 6 7 8 9 10

6. **How successful do you expect to be quitting smoking?** (Scale of 1 t0 10 with = lowest expectation of success and 10 = high expectation of success.)
   0 1 2 3 4 5 6 7 8 9 10
7. **How many cigarettes per day do you usually smoke?**

| 0-4 Cigarettes | 5-9 Cigarettes | 10 -14 Cigarettes | 15 -19 Cigarettes | 20 – 29 Cigarettes | 30+ Cigarettes |
|---|---|---|---|---|---|

8. **On days that you can smoke freely, how soon after you wake up do you smoke your first cigarette of the day?**

| 0 – 5 Minutes | 6 – 15 Minutes | 16 – 30 Minutes | 31 – 60 Minutes | 61 – 120 Minutes | 121+ Minutes |
|---|---|---|---|---|---|

9. **Do you sometimes awaken at night to have a cigarette?**

| Yes | No |
|---|---|

10. **If yes, how many nights per week do you typically awaken to smoke?**

| 0 -1 Nights | 2 -3 Nights | 4+ Nights |
|---|---|---|

11. **Do you smoke now because it is really hard to quit?**

| Yes | No |
|---|---|

**12. Do you ever have strong cravings to smoke?**

| Yes | No |
|---|---|

**13. Over the past week, how strong have the urges to smoke been?**

| None/Slight | Moderate/Strong | Very Strong/Extremely Strong |
|---|---|---|

**14. Is it hard to keep from smoking in places where you are not supposed to?**

| Yes | No |
|---|---|

**When you haven't used tobacco for a while or when you tried to stop smoking ...**

**15. Did you feel more irritable because you couldn't smoke?**

| Yes | No |
|---|---|

**16. Did you feel nervous, restless, or anxious because you couldn't smoke?**

| Yes | No |
|---|---|

**Last Section Part Seven: Demographic**

**Please check the appropriate answers:**

**1. Gender**

- ☐ Male
- ☐ Female
- ☐ Other (e.g. transgender) _____

**2. Ethnicity - Are you of Hispanic or Latino descent?**

- ☐ Yes
- ☐ No
- ☐ Not sure

**3. Race - What racial group(s) best describes your background? (If "yes" to 2. What racial group(s) best describes your background IN ADDITION TO Hispanic or Latino?)**

- ☐ African-American / Black
- ☐ Asian / Filipino
- ☐ Pacific Islander / Native Hawaiian
- ☐ Caucasian / White
- ☐ American Indian / Alaskan Native
- ☐ More than one ethnic group
- ☐ Other _____ (please specify)
- ☐ Not known

**4. Marital Status**

a. What is your current marital status?

- ☐ Married
- ☐ Divorced, Separated
- ☐ Widowed
- ☐ Single, never married

b. Do you live with a spouse or intimate partner?

- ☐ Yes
- ☐ No

**5. Age** _____

**6. Occupational Status**

- ☐ Employed
- ☐ Unemployed
- ☐ Retired
- ☐ Full-time homemaker
- ☐ Student (not employed)

**7. Occupation** (If retired or unemployed, check the most recent or longest held occupation)

- ☐ Professional or technical (accountant, architect, engineer, computer programmer, lawyer or judge, scientist, doctor, registered nurse, teacher, social worker, writer, entertainer)
- ☐ Manager and administrator (office manager, sales manager, school administrator, government official, small business owner)
- ☐ Sales (sales representative, insurance agent, real estate broker, bond salesman, sales clerk or other sales people)
- ☐ Clerical or office worker (bank teller, bookkeeper, secretary, typist, postal clerk or carrier, ticket agent)
- ☐ Craft (baker, carpenter, electrician, bricklayer, mechanic, machinist, tool and die maker, telephone installer)
- ☐ Operative (assembler, checker, gas station attendant, meat cutter, packer, laundry and dry-cleaning operative, mine operative, welder, garage worker)
- ☐ Transportation equipment operative (bus driver, cab driver or chauffeur, truck driver and deliveryman)
- ☐ Laborer (construction, freight handler, sanitation worker)
- ☐ Private household worker (maid, butler, cook)
- ☐ Service worker (cook, waiter, barber, janitor, practical nurse, beautician, police officer, fireman)
- ☐ Military service
- ☐ Never / not otherwise employed

**8. Education** (check the box of highest level completed)

a) Years completed if 12 or less: _____

b) Highest degree completed (check box)

- ☐ High School, GED
- ☐ A.A., A.S., other vocational program
- ☐ B.A., B.S. etc.
- ☐ M.A., M.S. etc.
- ☐ Ph.D., M.D., J.D. etc.

**9. Current living situation** (check the box that applies)

- ☐ House or apartment (you rent or own)
- ☐ House or apartment of friend or relative
- ☐ Halfway house or residence in therapeutic community
- ☐ Single room occupancy (SRO), hotel motel
- ☐ Homeless (streets, shelter, car, no stable arrangement)
- ☐ Institution (jail, hospital)
- ☐ Other _____ (Please specify)

**10. How long have you lived there?**

_____ / _____
yrs mos

**11. Sexual orientation** (check the box)

- ☐ homosexual/gay/lesbian
- ☐ heterosexual
- ☐ bisexual

**12. Did you serve in the Armed Forces for the United States?**

☐ Yes ☐ No

**13. Yearly Individual Income** (check the box that applies)

- ☐ Less than $10,000
- ☐ $11,000 - $20,000
- ☐ $21,000 - $30,000
- ☐ $31,000 - $40,000
- ☐ $41,000 - $50,000
- ☐ $51,000 - $60,000
- ☐ $61,000 - $70,000
- ☐ $71,000 - $80,000
- ☐ $81,000 - $90,000
- ☐ $91,000 - $100,000
- ☐ over $100,000

END of Survey. Thank you so much for your time