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Max Gunnar Behrens
University of Vermont

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Max Gunnar Stjärne Behrens

University of Vermont

Abstract

While rates of conventional cigarette smoking having steadily decreased over the past several decades, more and more individuals are beginning to use alternative nicotine products such as e-cigarettes. Chief among these users are young adults, who use the devices at rates higher than any other population. While e-cigarettes have demonstrated the potential to act as tools to aid in the process of conventional cigarette cessation among adult smokers, young adults do not often indicate cessation to be a motivation driving their e-cigarette use. In addition, research has demonstrated that among younger users, e-cigarettes have the potential to lead to future conventional cigarette use. As such, it is important to better understand the motivations underlying e-cigarette use that young adults do identify with. Previous research has indicated the relative importance of both affective and social motivations for use. The current study included these categories as well as categories based on analytical and biological motivations in order to assess participants on a wide range of possible motivations. Consistent with previous research, the results of the current study indicated the importance of affective motivations in driving e-cigarette use. However, participants did not demonstrate the same level of agreement with the social, analytical, and biological motivations. Interventions aimed at reducing the rates of e-cigarette use among young adults would therefore likely benefit from targeting these affective motivations underlying use.

Keywords: e-cigarettes, conventional cigarettes, nicotine, young adults, motivations

Introduction

The Current State of Cigarette Smoking

In the United States, cigarette smoking remains the number one cause of preventable death and disease, killing nearly half a million individuals annually – including 50,000 nonsmokers who have been exposed to secondhand smoke (U.S. Department of Health and Human Services, 2014). This is despite the fact that smoking has declined among adults to a record low of 13.7% in 2018 (Creamer et al., 2018). Indeed, cigarette smoking has declined worldwide over the last several decades. From 1980 to 2012, the percentage of global daily smokers decreased among men from 41.2% to 31.1%, and among women from 10.6% to 6.2%. However, due to population growth, the overall number of daily smokers increased from 721 million in 1980 to 967 million in 2012 (Ng et al., 2014). As of 2018, this figure has grown to approximately 1 billion smokers worldwide (Drope et al., 2018).

Research has shown that certain groups are at a higher risk for cigarette smoking when compared to the general public. Among individuals with other substance use disorders, tobacco use is high; 75% of adults with alcohol use disorder and 90% of adults with drug use disorders also smoke tobacco (Chou et al., 2016). Additionally, almost 90% of individuals who smoke started by the age of 18 (Prochaska & Benowitz, 2019), highlighting the importance of further research regarding tobacco use in young people.

It is well known that cigarette smoking has detrimental effects on an individual's health and wellbeing. Research has shown that more than half of all long-term smokers die from a tobacco-related disease, with the average long-term smoker losing at least 10 years of life (U.S. Department of Health and Human Services, 2014). According to some projections, an estimated 1 billion people will die worldwide due to tobacco by the end of this century (Drope et al., 2018).

The Health Effects of Cigarettes

Among the myriad of negative health effects that have been linked to cigarette smoking are increases in the rate of developing cardiovascular disease. Smoking cigarettes increases the rate of acute coronary and cerebrovascular events, including myocardial infarction, stroke, and death (Benowitz & Burbank, 2016). Furthermore, cigarette smoking increases an individual's risk of developing atrial fibrillations (Benowitz & Burbank, 2016), which are irregular and often rapid heart rhythms that can lead to blood clots in the heart, increasing the risk of stroke, heart failure, and other complications.

In addition to cardiovascular disease, cigarette smoking has long been linked to increases in the incidence of cancer. Cigarette smoke contains over 9000 chemicals, many of which are known carcinogens, with the majority being products of the combustion of tobacco (Benowitz & Burbank, 2016). According to the U.S. Department of Health and Human Services, there is ample evidence to support the fact that many of the major classes of chemicals emitted through the burning of tobacco are toxic and carcinogenic (U.S. Department of Health and Human Services, 2010). One of the more common forms of cancer that results from cigarette smoking is that of the lungs. Research has established that cigarette smoking is a major cause of lung cancer, attributable to 85% of all lung cancers (U.S. Department of Health and Human Services, 2010). Interestingly, although lung cancer is now the leading cause of cancer death in the US, killing an estimated 160,000 people annually, it was once a very rare disease. A review of the worldwide scientific literature titled *Primary Malignant Growths of the Lungs and Bronchi* published in 1912 was only able to identify 374 verified cases of lung cancer (U.S. Department of Health and Human Services, 2010). While lung cancer may be one of the most common negative health outcomes associated with cigarette smoking, research has also demonstrated that more generally, DNA adduct levels

are higher in tissue samples from smokers as compared to nonsmokers. Adducts can cause mutations in an individual's genetic code, leading to tumor formation and growth as well as the development of a range of different cancers (U.S. Department of Health and Human Services, 2010).

Although cardiovascular disease and cancer tend to dominate the discussion when it comes to the health effects of cigarette smoking, there are numerous other negative outcomes worth noting. Research has demonstrated that cigarette smoking leads to the progression and aggravation of heart failure and chronic kidney disease (Benowitz & Burbank, 2016). Additionally, oxidative stress due to cigarette smoking can lead to the development of chronic obstructive pulmonary disease (COPD), a condition which causes an obstruction of airflow from the lungs due to inflammation (U.S. Department of Health and Human Services, 2010). Finally, cigarette smoking causes insulin resistance as well as chronic inflammation, which can lead to a range of poor health outcomes (U.S. Department of Health and Human Services, 2010).

The Addictive Nature of Nicotine

An important variable to consider when discussing the detrimental effects of cigarette smoking is the addictive nature of nicotine itself. Despite the ongoing opioid epidemic and related overdose deaths, nicotine addiction kills more than twice as many individuals as all other substance use disorders combined (Kolodner et al., 2022). In addition, as previously alluded to, there is a strong association between individuals with substance use disorders and cigarette smoking. Research has also demonstrated that tobacco addiction is far more common in individuals with mental illness and substance use disorders, who represent only 22% of the population yet consume 44% of all cigarettes sold in the US (Benowtiz, 2009).

Previous research has also demonstrated that nicotine, and by extension cigarettes, are some of the most difficult substances to quit once an individual has become addicted to them. In 2015, 55.4% of adult smokers in the US made a quit attempt, yet only 7.4% of them were successful (Babb et. al., 2017). Furthermore, approximately 80% of smokers who try to quit on their own relapse within a month, with only around 3% still being abstinent at 6 months (Benowtiz, 2009). These statistics are sobering in that they demonstrate the relatively low success smokers often find when attempting to quit cigarettes. However, this low likelihood of success is not due to a lack of motivation. That is, while two-thirds of tobacco smokers do have a desire to quit, it still takes an average of 6 attempts in order to achieve stable abstinence (Kolodner et al., 2022). Furthermore, while many individuals seek out medical assistance when trying to achieve abstinence from cigarettes, the success rates associated with these evidence-based therapies is still low. For example, studies assessing the real-world application of nicotine replacement therapies (NRTs) show that although they confer almost double the success rate in terms of cessation, these success rates are still low in absolute terms, with long term abstinence among participants being less than 20% (Rose, 2006).

The Current State of E-cigarettes

When considering the scale and related health implications of cigarette smoking, it is important to investigate potential tools that might assist current smokers in their quit attempts while simultaneously working to prevent the development of nicotine addictions among current non-smokers. One such tool are electronic nicotine delivery systems (ENDS), or as they are more commonly referred to, e-cigarettes. E-cigarettes are battery-powered vaporizers consisting of a

heating element as well as a solution containing propylene glycol, glycerol, and nicotine, in addition to a range of possible flavors (Bhatnagar, 2016).

When discussing e-cigarettes as a possible tool to aid in the process of cigarette cessation among adult current smokers, it is important to note that young adults as a population use these devices more than any other age group. In fact, according to the 2016 Surgeon General's report, from 2013 to 2014, the number of young adults who reported ever using an e-cigarette more than doubled (National Center for Chronic Disease Prevention and Health Promotion, 2016). A similar pattern emerged between 2017 and 2018, where e-cigarette use among high school students increased by 78% (Gentzke et al., 2019). This may have been due to a surge in marketing that targeted certain demographics or simply an increase in the availability of e-cigarettes in general. In 2014, 35.8% of young adults reported having ever used an e-cigarette (National Center for Chronic Disease Prevention and Health Promotion, 2016), yet in 2018 only 3.2% of adults reported the same (Creamer et. al., 2018). This may demonstrate that e-cigarettes are not being used primarily by their intended audience.

Research seems to also suggest that young adults are now more likely to be using e-cigarettes rather than conventional cigarettes. According to Gentzke and colleagues, in 2018, 27.1% of high school students reported current use of any tobacco product, with e-cigarettes being the most commonly used product at 20.8% (Gentzke et al., 2019). Similar studies have found prevalence rates for e-cigarette use among young adults between 22-30%, growing more rapidly than any other age group (Lanza & Teeter, 2018). More recent data seems to support these figures, indicating that in 2022, 27.3% of 12th graders indicated vaping nicotine within the past year (U.S. Department of Health and Human Services, 2022). It is also interesting to note that among adolescents who use tobacco, 70% use a flavored product (Centers for Disease Control and

Prevention, 2015). Overall, these rates are alarmingly high and demonstrate the need to understand the underlying motivations for e-cigarette use among young adults.

The Health Effects of E-cigarettes

Since their creation, e-cigarettes have been marketed to adult current smokers as a less harmful alternative to smoking conventional cigarettes. Compared to conventional cigarettes, the risk of developing cardiovascular complications from e-cigarette use is quite low for individuals without preexisting cardiovascular disease (Benowitz & Burbank, 2016). Even among individuals who do have a preexisting cardiovascular condition, the risk of further complications from e-cigarettes is far less than the risk associated with smoking conventional cigarettes, such that completely substituting conventional cigarettes with e-cigarettes results in a net benefit for cardiovascular health (Benowitz & Burbank, 2016). However, it is important to note that differences in harm are relative to those observed in individuals who smoke conventional cigarettes. For example, some chemicals associated with the combustion of tobacco have still been found to be present in e-cigarette aerosols, such as carbonyls like formaldehyde. While the current research is not conclusive on the effects of formaldehyde in the concentrations found in e-cigarettes, it is possible that inhaling this chemical could affect respiration, myocardial function, and blood pressure regulation (Bhatnagar, 2016).

In the context of cancer, because many of the harmful and carcinogenic chemicals associated with cigarette smoking are a product of the combustion of tobacco, consuming nicotine using an e-cigarette reduces an individual's degree of exposure to those chemicals, including carbon monoxide and carcinogenic nitrosamines (Bhatnagar, 2016). Furthermore, researchers have analyzed the degree to which many of these harmful compounds are still present in e-cigarettes. In

studies assessing the toxic compounds produced by e-cigarettes, including carbonyls, volatile organic compounds (VOCs), tobacco-specific nitrosamines (TSNAs), and heavy metals, researchers found that the levels measured in e-cigarette vapors were between 9 and 450 times lower than those found in conventional cigarette smoke (Goniewicz, 2013). It is worth noting that there could be a lag time in terms of seeing the carcinogenic effects of e-cigarettes, as very little long-term data exists at present. However, it currently seems as though e-cigarettes are a less harmful alternative.

Researchers have demonstrated that nicotine may also be a driving factor in some of the negative health outcomes discussed above. However, the negative health effects of nicotine itself are likely far lower when compared with smoking cigarettes, which exposes individuals to both nicotine as well as thousands of toxic chemicals produced by the combustion of tobacco (Morris et al., 2015). Furthermore, research supports that nicotine is not a major contributor to the kind of chronic inflammatory state that is often caused by smoking (Benowitz & Burbank, 2016). While nicotine is the main active ingredient present in e-cigarettes, these devices often also contain one of a multitude of different flavors. Flavors currently used in e-cigarettes are regarded as "food grade" and are therefore safe for consumption – however, less is known regarding their safety when these flavorings are instead heated and then inhaled (Bhatnagar, 2016). Overall, while there still is important research to be done on the long-term effects of use, e-cigarettes do seem to be a less harmful alternative for current smokers when compared to conventional cigarettes.

The Role of E-cigarettes in Reducing Conventional Cigarette Consumption

In line with some of the claims made by tobacco companies, recent research indicates that e-cigarettes have the potential to reduce the number of conventional cigarettes consumed on a daily

basis by current smokers. One study assessing adult daily smokers found that the more frequently participants used an e-cigarette, the fewer conventional cigarettes they consumed (Pearson et al., 2021). Many of these participants expressed difficulty transitioning completely to e-cigarettes however, citing the lack of nicotine delivery as well as a decreased sense of satisfaction when using the product. This was especially true among menthol smokers, smokers older than 45, and individuals who began smoking at a young age (Pearson et al., 2021). To this end, it is important to consider the degree to which e-cigarettes can serve as substitutes for conventional cigarettes. A New Zealand based study assessed just that, finding that demand for cigarettes at their current market price decreased by 42.8% when e-cigarettes were available (Grace et al., 2015). However, this study also demonstrated that the availability of e-cigarettes may discourage current smokers from quitting entirely, as when cigarettes cost twice the current market price, significantly more participants indicated that they would quit entirely if no e-cigarettes were available (50.2%) as compared to if they were (30.0%) (Grace et al., 2015).

The Role of E-cigarettes in Facilitating Conventional Cigarette Cessation

In addition to reducing the number of cigarettes an individual consumes, research has demonstrated that e-cigarettes can aid current smokers in quitting cigarettes entirely. One study assessing how e-cigarettes impacted cessation success sampled 9,724 adult current smokers from three waves of the Population Assessment of Tobacco and Health (PATH) study. The PATH study is a nationally representative longitudinal study of youth and adults in the United States, and therefore very generalizable. The authors found that increasing the frequency of e-cigarette use across waves was associated with an increased likelihood of quitting cigarettes in both the short and long term as compared to individuals who never used e-cigarettes (Glasser et. al., 2021).

However, an important caveat is that this association was present only among daily smokers; for nondaily smokers, an increase in e-cigarette use across waves was in fact associated with a decreased likelihood of quitting. These findings were also corroborated by another team of researchers utilizing data from the PATH study (Berry, Reynolds, et al., 2019). The effectiveness of e-cigarettes as smoking cessation tools therefore seems to be dependent on a multitude of factors such as frequency, duration, type, and consistency of use.

Similar findings were observed in a study that utilized data from the National Health Interview Survey (NHIS) from 2006 to 2016 (N = 26,354) as well as the Tobacco Use Supplement to the Current Population Survey (TUS-CPS) from 2006-2007, 2010-2011, and 2014-2015 (N = 33,627). Researchers demonstrated that past 12-month quit attempts and cessation success increased significantly during years of increased e-cigarette use, with cigarette smokers who indicated current e-cigarette use reporting significantly more attempts to quit as well as success in doing so as compared to individuals who were not using e-cigarettes (Johnson et al., 2019). Although causality cannot be deduced from these studies, they can help demonstrate the potential for e-cigarettes to aid individuals who are attempting to quit smoking conventional cigarettes.

Research has also demonstrated that e-cigarettes may serve as a more beneficial cessation tool than existing tools such as nicotine-replacement therapy (NRT). One study, which randomly assigned 886 participants to either an e-cigarette group or an NRT group, found that the 1-year abstinence rate from conventional cigarettes was 18% in the e-cigarette group as compared to 9.9% in the NRT group. However, an important among those participants who were able to quit was that one year later, 80% of individuals in the e-cigarette group were still using their assigned product as compared to 9% of individuals in the NRT group (Hajek et al., 2019). This evidence supports the role of e-cigarettes as beneficial devices in the context of conventional cigarette cessation.

The Role of E-cigarettes in Future Conventional Cigarette Use

Although these findings may inspire optimism in terms of the potential benefits of e-cigarettes, previous research has also demonstrated that e-cigarette use is associated with future conventional cigarette use. A systematic review and meta-analysis of nine longitudinal studies, comprising a total of 17,389 participants, found that e-cigarette use is associated with an increased likelihood of future and current cigarette smoking among adolescents and young adults, even after adjusting for demographic, psychosocial, and behavioral risk factors (Soneji et. al., 2017). The authors suggested that this could be due to e-cigarettes mimicking many of the behaviors associated with cigarette smoking or may be attributable to the development of a nicotine addiction that then causes the individual to seek out conventional cigarettes. Similar results were observed in a study which surveyed 3,757 students from a Mid-Atlantic university at two different time points, finding that among participants who reported never smoking conventional cigarettes at time 1, individuals who had ever tried or were currently using e-cigarettes were more likely to have tried conventional cigarettes by time 2 compared to individuals who had not used e-cigarettes (Spindle et al., 2017).

A similar study followed 3,426 young adults who reported never having used tobacco products over the course of two years. The authors found that respondents who indicated they had used e-cigarettes at the one-year point were more likely to use combustible cigarettes over a twelve-month period following their initial e-cigarette use (Hair et al., 2021). This indicates that even among nicotine naïve young adults, e-cigarette use may represent a risk factor for future conventional cigarette smoking. It is also important to analyze whether e-cigarettes are increasingly becoming the first tobacco product used by adolescents and young adults. Using three

waves of the Population Assessment of Tobacco and Health (PATH) study, Barry and colleagues assessed 6,123 youths aged between 12 and 15 who had never used any tobacco products at wave 1. The authors found that, over the course of waves 2 and 3, e-cigarettes were the most common first tobacco product (8.6%) compared to cigarettes (3.3%). In addition, cigarette use at wave 3 was higher among previous e-cigarette users (20.5%) compared with individuals with no prior tobacco use (3.8%) (Berry, Fetterman et al., 2019). These results indicate not only that youth and young adults may be more at risk for conventional cigarette use given use of e-cigarettes, but also that these e-cigarettes are serving as their primary exposure to nicotine.

Young Adults Are Not Primarily Using E-cigarettes as Reduction/Cessation Tools

While e-cigarettes are often marketed to adult current smokers as cessation tools, when surveyed as to their motivations for using e-cigarettes, youth and young adults do not report using the devices to help them quit conventional cigarettes as a primary reason (National Center for Chronic Disease Prevention and Health Promotion, 2016). In addition, research indicates that young adults are less likely than older adults to use e-cigarettes as an alternative to conventional cigarettes or as a tool to help them quit conventional cigarettes. Young adults also demonstrate the lowest odds of likely quitting use of tobacco or nicotine products generally as compared to other age groups (Vu et al., 2019). While using e-cigarettes to help in a quit attempt represents a net health benefit, if e-cigarettes are not being used for this purpose, and instead facilitating transitions to conventional cigarettes, they may instead represent a gateway for young adults to develop an addiction to nicotine.

Affective/Social-Based Motivations for E-cigarette Use Among Young Adults

Instead of using e-cigarettes to help quit smoking conventional cigarettes, some of the more commonly listed reasons for e-cigarette use among young adults include curiosity and flavoring/taste (National Center for Chronic Disease Prevention and Health Promotion, 2016). This finding has been corroborated by other researchers. That is, according to a review assessing the motivations for using e-cigarettes among young adults, the most commonly reported reason for initiating use was curiosity (Kinouani et al., 2020). Similar studies have found that among current e-cigarette users in a population of college students, 72.3% report using e-cigarettes for enjoyment, trying something new, or other affect related reasons (Saddleson et. al., 2016). Among 3,398 students from an Appalachian university, students most commonly reported using e-cigarettes to decrease stress, because they tasted good, and because their friends use them (Wattick et al., 2021). Taken together, these studies seem to demonstrate that affect-related reasons are more often being cited by young adults than analytical reasons when it comes to their motivations for using e-cigarettes.

In addition to affective-based reasons, young adults may feel social pressure to use e-cigarettes. On many university campuses, there is a disconnect between student's perceptions about e-cigarette use and actual use. According to the ACHA National College Health Assessment II (ACHA-NCHA II), while students perceived that 79.9% of their peers used e-cigarettes within the last 30 days, in reality only 12.9% reported doing so (American College Health Association, 2018). This is a staggering difference and could lead to students feeling increased social pressure to use e-cigarettes due to their perception that everyone around them is. Other research from the literature has also emphasized the importance of social pressure when it comes to e-cigarette use among young adults. A focus group-based study found that among adolescents, the most common

reasons for e-cigarette use were socially motivated (i.e., friends used them) as well as stress relief, ease of access, the buzz it provided, and to deal with boredom (Kong et al., 2021). In addition, research has shown that young adults are more likely to begin using e-cigarettes for reasons such as the available flavors or a friend's use (Vu et al., 2019). These motivations for use might therefore be important to explore more in depth, as they could play a role in guiding regulatory efforts.

Biological/Analytical-Based Motivations for E-cigarette Use Among Young Adults

While not as common as the aforementioned affective and social-based motivations for e-cigarette use, young adults also list what could be described as analytical and biological-based motivations for their e-cigarette use. One such analytical motivation for using e-cigarettes is their low perceived harm in comparison to other tobacco products (National Center for Chronic Disease Prevention and Health Promotion, 2016). On the biological side, according to one study, which assessed young adults' relationship with vaping as well as food, some individuals reported intentionally using e-cigarettes to suppress their appetite and control their weight (Kechter et al., 2022). These studies demonstrate that there may be a great deal of variability when it comes to the reasons young adults are using e-cigarettes.

Equally important is the need to investigate the role of information when it comes to e-cigarette use among young adults. Research has demonstrated how misconceptions about e-cigarettes might contribute to their use. For example, these e-cigarette related misperceptions were more prevalent among individuals who had used an e-cigarette in the past 30 days as compared to those who had never used an e-cigarette. In addition, Gaiha and colleagues found that past 30-day use of an e-cigarette was associated with beliefs including that e-cigarettes do not increase the risk of developing severe lung disease or that they are safer than cigarettes (Gaiha et al., 2022).

Relatedly, other research has looked at the effects e-cigarette marketing might have on young adults, finding that college students who were more receptive to e-cigarette marketing were also more likely to believe that the devices are less harmful than conventional cigarettes, and were more likely to use them (Pokhrel et al., 2015). These findings are important in that they highlight the important role accurate information could play in promoting or limiting the use of e-cigarettes among young adults.

Rationale for the Current Study

This study aimed to assess the degree to which the trends found in the literature regarding the motivations underlying e-cigarette use among young adults are generalizable. Previous research with college students has demonstrated that motivations for using e-cigarettes tend to be more affectively and socially based. It is therefore reasonable to assume that the same will apply to Vermont undergraduate students, who will be the focus of the current study. However, as discussed above, research has also demonstrated that among young adults, some individuals also identify with more biologically based motivations, such as using e-cigarettes as an appetite suppressant, as well as more analytically based motivations, such as the perception that e-cigarettes are less harmful. To this end, the current study employed four broad categories of statements that describe motivations for using e-cigarettes, those being affective, social, biological, and analytical based motivations. Within each of these four broad categories are a range of statements that are aimed at capturing the myriad of reasons a young adult might choose to use e-cigarettes.

While these broader categories of motivations have a basis in the current research present in the literature, many of these past studies have tended to include a very limited selection of possible motivations. In this study, the number of motivations was increased to include a greater

variety, such as use based on a certain image e-cigarette use might portray to others, use based on the desire to avoid smelling like cigarette smoke, use based on convenience factors such as price or the ability to use in more locations, and use based on factors such as cravings or the desire to aid with focusing. The current study also aimed to assess the degree to which there are differences in the motivations underlying e-cigarette use between subpopulations within the more general population of young adults. The main subpopulations of interest for this study were exclusive e-cigarette users and e-cigarette/conventional cigarette dual users, to analyze if these two groups differed on their self-reported motivations for using e-cigarettes. By analyzing which motivations were most important among young adults, the current research aimed to identify possible targets for interventions that might reduce the rates of e-cigarette use among this population.

Methods

Participants

This study used a convenience sample of undergraduate students currently attending the University of Vermont, located in Burlington, Vermont. To participate in the study, each individual had to (a) be at least 18 years old, (b) able to independently read and comprehend written materials, (c) have used an e-cigarette on at least 3 of the last 30 days, and (d) provide informed consent. To protect their confidentiality, no participant's names were collected. This study was approved by the University of Vermont IRB (00002347).

Materials

The survey was divided into three main sections. The first section collected demographic information such as the participants age, gender identity, race, current class standing, current

employment status, and current tobacco product use (i.e., whether they use only e-cigarettes or combustible cigarettes in addition to e-cigarettes).

The next section contained two measures to assess nicotine dependence, the Fagerström Test for Nicotine Dependence (FTND; Heatherton, et al., 1991) to examine nicotine dependence to combustible cigarettes, and the Penn State Electronic Cigarette Dependence Index to examine nicotine dependence to e-cigarettes (Foulds et al., 2015). If a participant indicated that they were currently using both e-cigarettes and combustible cigarettes, they were first directed to complete the FTND, followed by the Penn State Electronic Cigarette Dependence Index. If a participant indicated exclusive e-cigarette use, they were directed to complete just the Penn State Electronic Cigarette Dependence Index.

The final section, and the primary focus of analysis for this study, contained a set of statements describing possible motivations for using e-cigarettes. Participants were asked to indicate their feelings toward each motivation for use on a 5-point Likert scale ranging from strongly disagree to strongly agree. The motivation statements were divided into four broad categories, including affective-based motivations (e.g., 'I use e-cigarettes because they taste good'), social-based motivations (e.g., 'I use e-cigarettes because my friends use them'), analytical-based motivations (e.g., 'I use e-cigarettes because they aren't as bad as conventional cigarettes'), and biological-based motivations (e.g., 'I use e-cigarettes because they help with nicotine cravings'). The full list of motivation statements can be found in Table 1. The order in which participants viewed these motivation statements was randomized for each participant who completed the survey.

Procedure

The survey used for this study was created and hosted using Qualtrics, an online survey platform which allowed individuals to participate remotely using their computer or phone given they had access to the corresponding link. In order to disseminate the survey, this link as well as a short description of the study itself was posted to the SONA system, a university affiliated research platform where undergraduate psychology students can choose to participate in studies in exchange for class credit. The survey was open to psychology students on SONA from mid-January until the beginning of March. During this time, additional participants were recruited through announcements to a range of different class pages on Blackboard, the primary online classroom platform utilized by the University of Vermont. This served to supplement the number of participants recruited through the SONA system as well as diversify the participant pool to include students from a wide range of disciplines.

Data Analysis

After all the responses were collected and the survey closed, the data was exported to Excel for organizing and cleaning, and then imported to SPSS for analysis. Based on the observed demographic differences, two main subpopulations were created, which differentiated by current tobacco product use (exclusive e-cigarette use versus conventional cigarette and e-cigarette dual use).

For the Fagerström Test for Nicotine Dependence, each participant was given a score from zero to ten, reflecting the degree to which they are dependent on nicotine. For this questionnaire, all the yes/no questions count as either one point (yes) or zero points (no). For the multiple-choice questions, the responses are on a scale of zero to three. A higher score out of ten reflects a greater

degree of nicotine dependence. An average nicotine dependence score was calculated for all participants who completed the Fagerström test (those who indicated they were currently smoking conventional cigarettes).

For the Penn State Electronic Cigarette Dependence Index, each yes/no question is counted as either one point (yes) or zero points (no). For the multiple-choice questions, each question is on a zero to five scale (for those questions with six possible responses), or a zero to two scale (for those questions with three possible responses). This questionnaire has a possible score of between zero and 20, with higher scores reflecting greater nicotine dependence. An average nicotine dependence score was calculated for all participants who completed the questionnaire, which represented the entire study population. In addition, participants were divided into exclusive e-cigarette users and combustible cigarette and e-cigarette dual users, with each of these subpopulations also receiving an average nicotine dependence score. To assess differences between the two types of users and their nicotine dependence scores, an independent samples t-test was used.

For the statements describing possible motivations for using e-cigarettes, the Likert-scale responses were converted into numeric values, with a response of strongly disagree corresponding to one point, all the way up to a response of strongly agree corresponding to five points. For the study population, an average score was calculated for each individual statement. An average score was also calculated for each of the broader categories of statements. To assess for differences in response behaviors regarding these motivation statement categories, a 2 (group: exclusive use, dual use) x 4 (motivation statement category) repeated measures ANOVA was utilized. This allowed for the analysis of differences between the four motivation statement categories for the whole population, as well as between the two usage type groups.

Results

A total of 75 participants completed the survey, with 72% (n = 54) identifying as female, 21.33% (n = 16) identifying as male, and 6.66% (n = 5) identifying as non-binary or other. The age of participants ranged from 18 to 22, with an average age of 19.44 (SD = 1.16). In terms of race, 89.87% (n = 71) identified as White, 7.59% (n = 6) identified as Asian, 1.27% (n = 1) identified as American Indian/Alaskan Native, and 1.27% (n = 1) identified as other. No participants identified as Black/African American or Native Hawaiian/Pacific Islander. Regarding current class standing, 29.33% (n = 22), 34.67% (n = 26), 21.33% (n = 16), and 14.67% (n = 11) indicated they were freshmen, sophomores, juniors, and seniors, respectively. When asked about their current employment status, 46.67% (n = 35) claimed they were unemployed, 44% (n = 33) claimed they worked 0-20 hours per week, and 9.33% (n = 7) claimed they worked 20-40 hours per week. No participants indicated working greater than 40 hours per week. Finally, participants were divided evenly between exclusive e-cigarette users (at 49.33% [n = 37]) and e-cigarette/conventional cigarette dual users (at 50.67% [n = 38]) (see Figure 1).

Figure 1

Usage Type Subpopulations
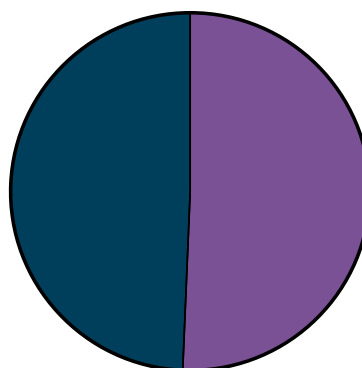
Exclusive Users *(n = 37)*
Dual Users *(n = 38)*
Total N = 75

The primary focus of analysis for this study was examining potential differences in response behavior for the four broad categories of motivation statements. These included motivations that were affectively, socially, analytically, and biologically based. Across the entire study sample (n = 75 participants), there were statistically significant differences between participants scores on each of these four categories of motivation statements, $F(3, 219) = 38.56$, $p < 0.001$ (see Figure 2). The category that participants indicated agreeing with most was the affective-based motivations ($M = 3.58$, $SD = 0.82$), while the category that participants indicated agreeing with least was the analytically based motivations ($M = 2.47$, $SD = 0.88$). The socially based motivations ($M = 2.66$, $SD = 0.84$), and the biologically based motivations ($M = 2.79$, $SD = 1.06$) were in the middle of the two and on average below a score of three.

Figure 2

*Category Averages Across the Whole Population*
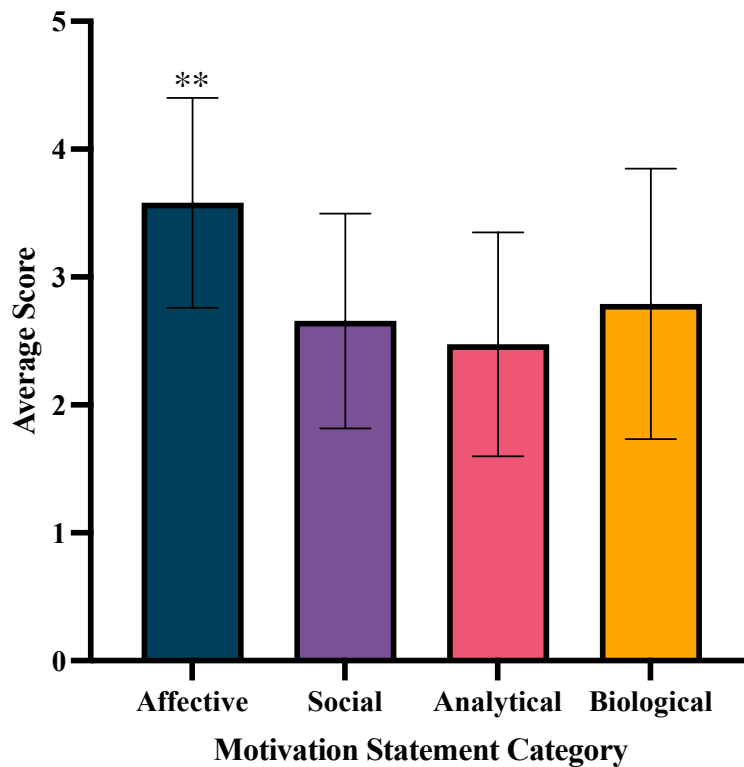
Note. ** denotes statistical significance; $F(3, 219) = 38.56$, $p < 0.001$

Regarding differences between the two subpopulations of exclusive e-cigarette versus dual users, the two-way repeated measures ANOVA demonstrated a statistically significant between-subjects effect, $F(1, 73) = 7.96$, $p = 0.006$, indicating the two usage type groups differed on their scores across all four motivation statement categories (see Figure 3). However, no statistically significant interaction effect was observed, $F(3, 219) = 1.61$, $p = 0.188$, indicating the difference in scores was not driven by specific categories. Across the four motivation statement categories, dual users indicated greater agreement and therefore higher scores than exclusive users (see Table 1).

Figure 3

Category Averages Across Usage Type Subpopulations
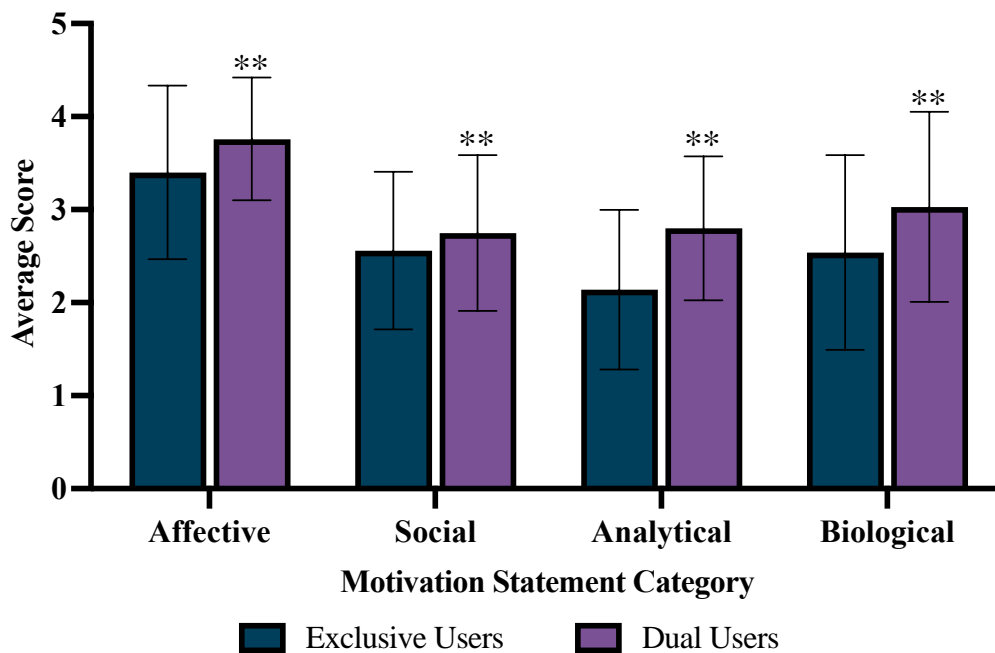
Note. ** denotes statistical significance; $F(1, 73) = 7.96$, $p = 0.006$
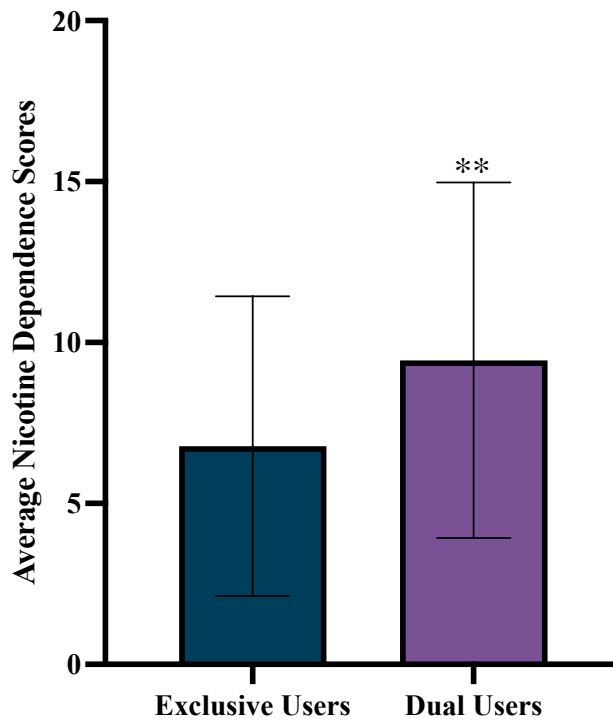
Table 1

Motivation Statement Category Average Scores

Motivation Statement Category	Overall		Exclusive Users		Dual Users	
	M	*SD*	*M*	*SD*	*M*	*SD*
Affective	3.58	0.820	3.40	0.932	3.76	0.660
Social	2.66	0.841	2.56	0.847	2.75	0.836
Analytical	2.47	0.875	2.14	0.857	2.80	0.773
Biological	2.79	1.057	2.54	1.048	3.03	1.020

The two usage subpopulations also displayed statistically significant differences on their nicotine dependence scores derived from the Penn State Electronic Cigarette Dependence Index, $F(73) = 0.31$, $p = 0.027$ (see Figure 4). Participants who indicated dual use of e-cigarettes and conventional cigarettes had on average higher scores ($M = 9.45$, $SD = 5.52$), than participants who indicated exclusive e-cigarette use ($M = 6.78$, $SD = 4.66$) (see Table 2). In addition to the Penn State Electronic Cigarette Dependence Index, the subpopulation of dual users also completed the Fagerström Test for Nicotine Dependence (FTND) and were each given a score corresponding to their degree of nicotine dependence in the context of cigarettes ($M = 2.08$, $SD = 2.06$), which indicated relatively low dependence.

Figure 4

Nicotine Dependence Scores Across Usage Types

Note. ** denotes statistical significance; $F(73) = 0.31$, $p = 0.027$
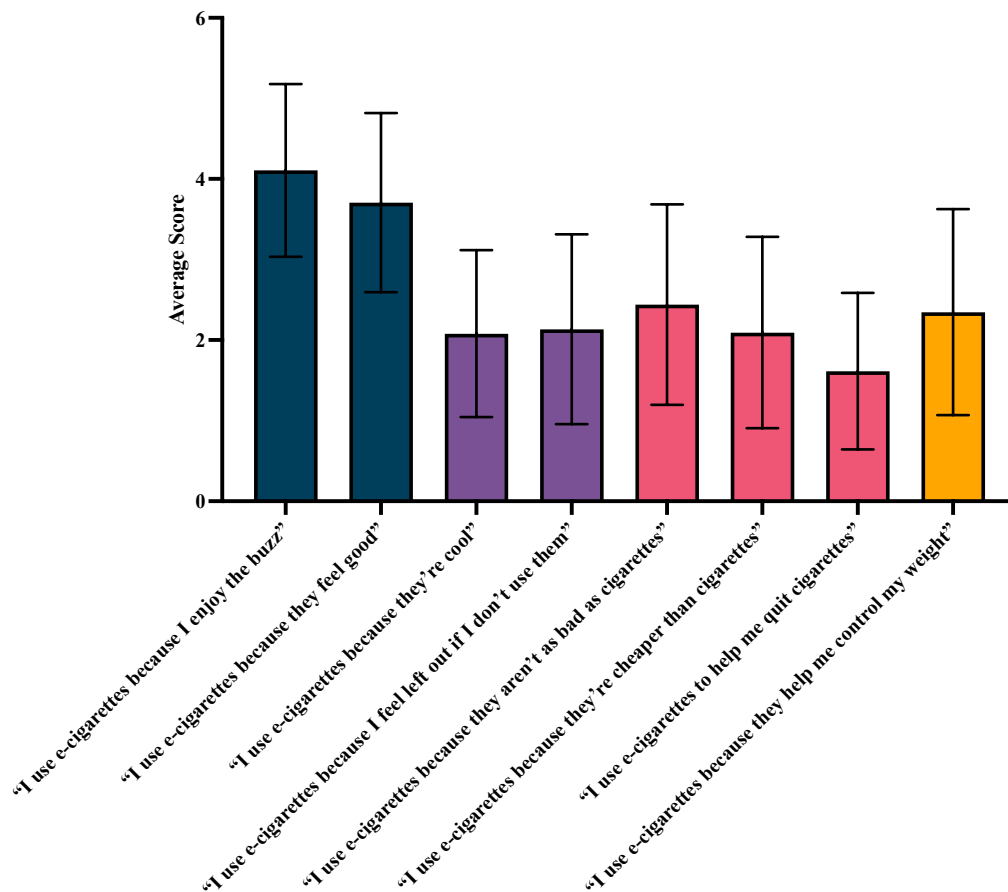
Table 2

Penn State Electronic Cigarette Dependence Index Average Scores

Population	M	SD
Whole Population	8.13	5.25
Exclusive Users	6.78	4.66
Dual Users	9.45	5.52

When looking at individual motivation statements, several stood out (see Figure 5). For the affective-based motivations, the statements "I use e-cigarettes because I enjoy the buzz" ($M = 4.11$, $SD = 1.07$), and "I use e-cigarettes because they feel good" ($M = 3.71$, $SD = 1.11$) were notable. For the socially based motivations, the statements "I use e-cigarettes because they're cool" ($M = 2.08$, $SD = 1.04$), and "I use e-cigarettes because I feel left out if I don't use them" ($M = 2.13$, $SD = 1.18$) were notable. For the analytically based motivations, the statements "I use e-cigarettes because they aren't as bad as cigarettes" ($M = 2.44$, $SD = 1.24$), "I use e-cigarettes because they're cheaper than cigarettes" ($M = 2.09$, $SD = 1.19$), and "I use e-cigarettes to help me quit cigarettes" ($M = 1.61$, $SD = 0.97$) were notable. Finally, for the biologically based motivations, the statement "I use e-cigarettes because they help me control my weight" ($M = 2.35$, $SD = 1.28$) was notable. The full list of averages as well as standard deviations for each individual motivation statement can be found in Tables 3, 4, 5, and 6.

Figure 5

Individual Statement Average Scores

Table 3

Affective Motivation Statements Average Scores

Affective Motivation Statements	M	SD
I use e-cigarettes because they taste good	3.23	1.290
I use e-cigarettes because they relax me	3.32	1.187
I use e-cigarettes because they're fun to use	3.55	1.154
I use e-cigarettes because I enjoy the buzz	4.11	1.073
I use e-cigarettes because they feel good	3.71	1.112

Table 4

Social Motivation Statements Average Scores

Social Motivation Statements	M	SD
I use e-cigarettes because my friends use them	3.09	1.210
I use e-cigarettes because they're cool	2.08	1.037
I use e-cigarettes because they're always easily accessible	3.32	1.377
I use e-cigarettes because I feel left out if I don't use them	2.13	1.178

Table 5

Analytical Motivation Statements Average Scores

Analytical Motivation Statements	M	SD
I use e-cigarettes because they aren't as bad as cigarettes	2.44	1.244
I use e-cigarettes to help me quit cigarettes	1.61	0.971
I use e-cigarettes so I don't smell like cigarette smoke	3.08	1.412
I use e-cigarettes because they're cheaper than cigarettes	2.09	1.187
I use e-cigarettes because I can use them in more places than cigarettes	3.15	1.363

Table 6

Biological Motivation Statements Average Scores

Biological Motivation Statements	M	SD
I use e-cigarettes because they help me control my weight	2.35	1.279
I use e-cigarettes because they decrease my appetite	2.68	1.377
I use e-cigarettes because they help with nicotine cravings	3.20	1.443
I use e-cigarettes because they help me focus	2.93	1.369

Discussion

Trends in Motivation Statement Categories Across the Whole Population

When looking at the study population as a whole, several important findings are worth discussing. The first is that on average, participants differed in agreement with each of the four categories of motivation statements. As depicted in Figure 2, participants were more agreeable with the affective motivations as compared to the social, analytical, and biological motivations. This finding is consistent with previous research indicating that among young adults, affect-related motivations are commonly cited as reasons underlying e-cigarette use (National Center for Chronic Disease Prevention and Health Promotion, 2016; Kinouani et al., 2020; Saddleson et. al., 2016; Wattick et al., 2021; Kong et al., 2021; Vu et al., 2019). These affective motivations can be based on taste, relaxation or stress reduction, fun, getting a buzz, feeling good, or curiosity, among others. The full list of affective motivation statements utilized for this study, as well as their corresponding means and standard deviations, can be found in Table 3.

Interestingly, participants were not as agreeable with the social motivations as they were with affective motivations. This contrasts with much of the previous research, which has indicated the importance of social-based reasons for using e-cigarettes (Wattick et al., 2021; Kong et al., 2021; Vu et al., 2019). This may be attributable to a change in perceptions regarding e-cigarettes or decreased emphasis being placed on peer pressure. Regarding peer pressure, previous research has often pointed towards a friend's use as a possible reason underlying e-cigarette use (Wattick et al., 2021; Kong et al., 2021; Vu et al., 2019). However, it is important to note the possibility that some participants may have been introduced to e-cigarettes by a friend yet might not identify their friend's use as a relevant motivation for their own continued use. Indeed, this could be the case for social motivations in general – that is, if participants had been using e-cigarettes for an extended

period, they might no longer identify with social motivations, even though these motivations may have precipitated use in the first place.

It may also be the case that social factors play less of a role in motivating e-cigarette use than indicated in the literature. Many e-cigarette users, and individuals who consume nicotine in general, are aware of the harmful effects of smoking and beginning habitual use of these substances. Although this knowledge may not be enough to motivate them to quit, it could dissuade them from pressuring or even promoting use to other non-smokers.

Trends in Individual Motivation Statements Across the Whole Population

In addition to broader trends present across the motivation categories, there were several individual motivation statements in each category worth analyzing in greater detail (see Figure 5). When looking at affective motivations, previous research has often focused on the importance of added flavors in e-cigarettes in motivating use among young adults (National Center for Chronic Disease Prevention and Health Promotion, 2016; Wattick et al., 2021; Vu et al., 2019). However, in the present study, participants on average did not seem to gravitate towards this motivation. Instead, among the affective motivations, the two with highest scores related to the ability of e-cigarettes to make the individual 'feel good,' as well as the buzz these devices provide (see Table 3). As opposed to a focus on flavor, the participants identified the subjective effects of nicotine itself as being an important motivation driving their e-cigarette use.

For social motivations, statements regarding a friend's use and ease of access received moderate scores on average, and participants reported much lower scores for the motivations based on e-cigarettes being 'cool' and the perception that they would be left out if they did not use the devices (see Table 4). Interestingly, these results seem to indicate a more negative perception

regarding e-cigarette use among the study population. As a result, peer pressure may be less of an important factor in terms of both continuing use among those who already do as well as promoting use to individuals who are currently abstinent.

Among the analytical motivations, three statements stood out, including that e-cigarettes are not as bad as conventional cigarettes, e-cigarettes being cheaper than conventional cigarettes, and e-cigarettes being used as tools to help the individual quit conventional cigarettes (see Table 5). On average, participants indicated lower scores to these three statements, with scores as ranging between disagree and strongly disagree in the case of use motivated by the desire to use e-cigarettes as cessation tools, which is consistent with previous research (National Center for Chronic Disease Prevention and Health Promotion, 2016). These results indicate that the study population viewed and used e-cigarettes as analogous products to conventional cigarettes as opposed to tools to aid in the process of cessation, which has been demonstrated in the literature (Vu et al., 2019). In addition, it illustrates that the participants are aware of the negative health effects associated with e-cigarette use yet continue to use these products regardless, which is in contrast to some previous findings (National Center for Chronic Disease Prevention and Health Promotion, 2016).

Finally, when looking at the biological motivations, although the statements describing use driven by nicotine cravings or a desire to focus received moderate scores, participants on average reported lower scores to the statements describing motivations based on controlling weight or decreasing one's appetite (see Table 6). While some research from the literature has indicated that certain individuals identify strongly with these motivations (Kechter et al., 2022), they likely represent a more niche group of users than those who were surveyed in this study.

Trends in Motivation Statement Categories Across the Usage Type Subpopulations

When discussing the two usage type subpopulations identified in this study, those being exclusive e-cigarette users and e-cigarette/conventional cigarette dual users, it is first important to note the almost exactly equal distribution between the two groups (see Figure 1). This is significant, as it indicates that among young adults who are smoking, many are engaging in use of multiple tobacco products.

Furthermore, there were statistically significant differences between the two usage type subpopulations in terms of their responses to each of the four motivation statement categories, with dual users indicating higher agreement across all four categories compared to exclusive e-cigarette users (see Figure 3). Although it is not entirely clear why dual users would agree with all of the provided categories to a greater extent than exclusive users, one possibility is that dual users, as a result of a greater degree of nicotine dependence, might have more reasons they could identify as motivating them to use e-cigarettes.

Trends in Nicotine Dependence Measures

On that note, it is worth discussing the nicotine dependence measures utilized by the current study. When looking at the Penn State Electronic Cigarette Dependence Index, the population had an average score of 8.13 (see Table 2). This corresponds to the upper limit of low dependence, verging on medium dependence (Foulds et. al., 2015), and indicates that on average, the population utilized for this study was comprised of occasional or experimental users as opposed to heavy users.

Interestingly, when looking at the Penn State Electronic Cigarette Dependence Index there were statistically significant differences between scores based on the two usage type

subpopulations (see Figure 4). Exclusive users had an average score of 6.78, compared to dual users who had an average score of 9.45 (see Table 2). This corresponds to the difference between being squarely in the low dependence category (for the exclusive users) and being in the medium dependence category (for the dual users). Moreover, this indicates that participants who specified dual use also demonstrated higher dependence on the nicotine consumed via their e-cigarettes.

Finally, when looking at the Fagerström Test for Nicotine Dependence (FTND) scores, which were calculated for all of the participants who indicated dual use of e-cigarettes and conventional cigarettes, the average was quite low at 2.08. This score corresponds to the low dependence category and seems to demonstrate that many of the participants who indicated dual use might be experimenting with conventional cigarettes or using them infrequently.

Variance Among Participants

Most of the measures utilized in the current study, including both those assessing nicotine dependence as well as the motivations underlying e-cigarette use, demonstrated a relatively high degree of variance. Looking at the Penn State Electronic Cigarette Dependence Index, the standard deviation for the scores of the whole population was 5.25 (see Table 2). To put it another way, one standard deviation below the population mean of 8.13 would be 2.88, while one standard deviation above the population mean would be 13.38. This effectively represents the difference between a participant falling into the low dependence category and a participant falling into the high dependence category.

As previously mentioned, a similar pattern emerged when looking at the motivation statement categories. For the sample population, the standard deviations for each motivation statement category ranged from around 0.8 to 1.0 (see Table 1). Since these categories were

evaluated on a five-point Likert scale, this variance represents the difference between a response of neutral and a response of either agree or disagree.

When analyzing why this variance might be present, it is important to consider the possibility of a large degree of variability in terms of how young adults are using e-cigarettes. Some individuals among the population utilized for the current study might best be described as experimental users, who are curious about e-cigarettes but have not yet formed a steady habit, and therefore might demonstrate relatively low nicotine dependence. On the other hand, some participants might best be described as heavy or daily users, for whom e-cigarette use is a habitual action repeated many times per day. These individuals would instead likely demonstrate relatively high nicotine dependence. For each of these potential classifications of e-cigarette users, there might be a range of different motivations driving use, some of which overlap while others are unique to each group. If this is the case, then when looking at possible interventions aimed at prevention or at promoting cessation, it would likely benefit the success of interventions to better distinguish between these different types of e-cigarette users. While an intervention whose target is based on dissuading the formation of an e-cigarette habit might be successful among experimental users, heavy users who are already engaging in daily use would likely not benefit from such an approach.

Possible Targets for Interventions

To that end, the results of the current study might inform possible targets for future interventions regarding e-cigarette use among young adults. As previously mentioned, the results of the current study demonstrated that social motivations did not appear to play as important a role in driving e-cigarette use as indicated in the literature. This would seem to imply that interventions

targeting such motivations, such as those attempting to combat peer pressure, are likely to not be as effective. While it is possible that interventions with this approach might find success in younger, more adolescent populations, it seems as though when looking at young adults as a population, there is less emphasis on the image or perception e-cigarette use is associated with.

Similarly, although the motivation statement pertaining to the flavors available in e-cigarettes received moderate scores, it did not stand out as being especially important in driving e-cigarette use among the target population. This might be a result of previous regulatory efforts that have cracked down on flavors or may be due to indifference on the part of young adults about the flavor of their e-cigarette, as long as it produces the desired positive sensations. While flavors may be especially important in the context of initiation among adolescents, it seems as though they are not held to as high a regard among young adults.

Due to the apparent significance of affective motivations, a target for intervention that may be more successful is one aimed at the subjective feelings associated with e-cigarettes. Because participants identified the buzz experienced from using e-cigarettes as an important motivation driving their use, one possible approach could be to decrease the amount of nicotine present in e-cigarettes. Since nicotine is the compound driving this buzz, an e-cigarette containing less nicotine would likely be perceived as less enjoyable and therefore might have the potential to disincentivize use.

However, while a seemingly simple solution, this approach would not be without problems. For one, if e-cigarettes across the board had maximum nicotine concentrations, such that they were decreased from their current levels, regulators run the risk of pushing some users to instead use conventional cigarettes to satisfy their nicotine cravings. If these heavier users had become accustomed to the concentration of nicotine currently present in e-cigarettes, a decrease from that

level might be enough of a motivation to cause a switch to conventional cigarettes, which would undoubtedly remain at a constant nicotine concentration. To this end, it is important to explore how tobacco purchasing behaviors might be affected by decreasing the nicotine concentration of e-cigarettes. One such tool that can aid in this process is the Experimental Tobacco Marketplace (ETM), which is a behavioral economic tool that assesses participants' tobacco purchasing behaviors under a range of potential market conditions. By utilizing tools such as the ETM, researchers might be able to get a clearer picture as to the potential effects of decreasing the nicotine concentration in e-cigarettes (Bickel et al., 2018).

In addition, more research is needed to assess the degree to which factors such as the buzz experienced by using e-cigarettes are important for adult current smokers. As discussed previously, research has demonstrated that among this population, e-cigarettes have the potential to act as tools to aid in the process of conventional cigarette cessation. If the subjective feelings associated with nicotine are important for these users, then decreasing the concentration of nicotine in e-cigarettes could lessen the effectiveness of these devices as cessation tools (Pearson et al., 2021). Although it is obviously important to prevent the increase in rates of e-cigarette use among young adults, there are clearly multiple populations using e-cigarettes for a range of different reasons. As such, finding a way to promote e-cigarettes as conventional cigarette cessation tools instead of alternatives to conventional cigarettes is an ideal, albeit difficult, end goal.

Limitations

The current study is not without limitations. There were several aspects of the demographics of the study that could have been improved upon, the first being the size of the sample utilized. While 75 participants does lend itself to some meaningful analyses, given a larger

timeframe with which the survey could have been open and collecting data, a larger sample and therefore greater statistical power would've likely been achieved. Next, when examining the demographics collected in the current study, a valid concern that may be raised is the homogeneity of the participants. Of the 75 participants, 72% were female, and almost 90% were white. However, it is important to note that the current study utilized a convenience sample of undergraduate students from the University of Vermont, which in general is a homogenous institution. Therefore, while there may be difficulties in extrapolating the results of the current study to young adults in general, the participants utilized are likely a somewhat accurate representation of the demographics of the University of Vermont, and possibly of the state of Vermont as well.

Another limitation of the current study is about the survey itself. Firstly, since the study relied on self-report data, there is a possibility that the participants did not accurately respond to the questions asked of them. This might be due to embarrassment on the part of the participants or a desire to finish the survey quickly, which could lead to the selection of random answers. However, the survey description did make explicit the anonymity of the results and was calculated to take only around ten minutes to complete. It is important nonetheless to note the potential limitation of utilizing self-report data as compared to more objective measures.

Furthermore, the fact that the survey utilized for this study employed a Likert scale for the responses to the motivation statements can potentially be considered a limitation. This is because Likert scales can be difficult to translate and later analyze numerically. Since each number on a Likert scale corresponds to a specific response, the question is whether the jumps between numbers are equivalent. For example, while the difference between a score of three and four and a score of four and five are both one, the difference between neutral and agree and agree and strongly agree may not be equal. Additionally, the utilization of a Likert scale may introduce the possibility of

floor and ceiling effects. In this context, a floor or ceiling effect would describe the limiting of responses to an absolute minimum or maximum. The issue arises in the possibility that this limiting of responses creates a situation where two participants give the same response while holding different beliefs regarding the statement in question. In other words, it begs the question of whether two responses of strongly agree or disagree are really the same.

Conclusions

Overall, the current study was successful in identifying several important findings in the context of e-cigarette use among young adults. Consistent with the previous research found in the literature, the results demonstrated the importance of affective motivations in driving e-cigarette use among young adults. However, in contrast to previous findings, participants placed less emphasis on the social motivations. This may be due to a change in perceptions regarding e-cigarettes or a lack of salience due to these social motivations not relating to reasons for continued use. Further research on why social motivations may be less important for young adults is warranted. In addition, important differences were demonstrated between the two usage type groups regarding nicotine dependence. While it is beyond the scope of the current study to assess causality, future research might attempt to further explore this question. Moreover, the high variance present in many of the measures utilized by this study seem to paint the picture of young adult e-cigarette users as a heterogenous population. This may lead to difficulties in terms of designing targeted interventions, as different types of e-cigarette users may require different styles of intervention. However, by further exploring the motivations behind e-cigarette use, researchers can hopefully better understand how to decrease use among young adults.

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