Association Between Age, Electronic Cigarette Use in Vehicles, and User Health Perceptions: A Cross-Sectional Analysis

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Abstract

Electronic cigarettes (ECIGs) have been increasingly popular over the past decade, especially with youth and young adults. Despite the lack of knowledge regarding the long-term health effects of ECIGs, we have seen the most use there has ever been in recent years. Additionally, the information regarding ECIG use in vehicles and the behaviors and attitudes towards use in vehicles is nascent. In this study, perceptions of ECIG use and user behavior within vehicles were analyzed in four different age groups — users who were aged 18-24, 25-44, 45-64, and 65+ years old. Study findings suggest associations between the four age groups, harm perceptions, and ECIG use behaviors inside of vehicles. For example, the youngest age group (18-24) was less likely to report using ECIGs in vehicles, while the age group 25-44 used ECIGs in vehicles more than other groups. This pattern continued, with the age group of 25-44 year-olds being more likely to use ECIGs in vehicles in the presence of children and other adults and being most likely relative to other age groups to report “Little or No Harm” when answering items about their personal ECIG harm perceptions. The age group of 18-24 year-olds had the highest harm perceptions of secondhand ECIG aerosols than any other age group despite being the age group with the highest ECIG use rates in the US. Understanding the perceptions and ECIG use behaviors in vehicles, especially how they pertain to reported differences associated with age, can inform policymakers and help to develop effective communication strategies for anti-vaping campaigns to identify and target vulnerable demographics.

Introduction

Electronic Cigarette Product and Prevalence Overview

Electronic Cigarettes (ECIGs) are devices that aerosolize a liquid that usually contains a mixture of nicotine, propylene glycol, vegetable glycerin, and other chemical flavorants (Walley & Jenssen, 2015). Most ECIG devices contain the same basic integral parts to operate: the battery, the heating element, the mouthpiece, and the fluid reservoir (Breland et al., 2017). ECIG users inhale from the mouthpiece which is usually made of a hard durable material such as plastic, metal, or wood. The mouthpiece has an airway that connects to the heating element, this allows for free air flow between the mouthpiece and heating element (on some models the airflow rate can be adjusted by the user). The heating element is powered by a battery and is usually controlled either by a button that the user must push to use or by a sensor-controlled switch that is activated by inhalation through the mouthpiece. When the heating element is powered, it heats up e-liquid (liquid that is aerosolized to be inhaled by users) or nicotine-salt solution that is on a filament and aerosolizes it so it can be inhaled by the user. The filament is connected to a liquid reservoir where the e-liquid is. The e-liquid on the filament is aerosolized during normal use so it draws more liquid as use persists until the reservoir is empty and the device is refilled or disposed of.

There have historically been 3 commonly recognized generations of ECIG devices including the ‘cig-a-like’ (first generation), the ‘vape pen’ (second generation), and the box mod (third generation) with ‘pod mods’ being a possible new generation of ECIG devices due to high popularity and unique characteristic not seen in previous generations (Williams & Talbot, 2019). Pod-mods have seen a rapid increase of use and popularity in recent years, especially after the discontinuation of flavored products from JUUL Labs (one of the largest ECIG companies in the

US) in retail stores (Delnevo et al., 2020). First generation devices have similar form-factors to traditional cigarettes, they usually have a fixed low-voltage battery. Some models can be refilled and recharged but many are designed to be disposable. Second generation devices typically have variable voltage batteries. They have removable cartridges, that can detach from a battery, which contains the heating element as well as the liquid reservoir. Second generation devices are meant to be refilled and rechargeable and usually have larger liquid reservoirs than first generation devices. Third-generation devices have the largest batteries compared to other generations, a lot of these batteries are highly modifiable with some devices having an interface that allows for control over variable voltage, wattage, etc. These larger batteries have a higher power output therefore produces more vapor (along with toxicants) which in turn changes the user experience and potentially their future health outcomes compared to other generations of ECIGs (Do et al., 2022).

ECIG devices have seen a considerable increase in use in recent years, especially among youth (McMillen et al., 2014). Current ECIG use among youth increased from 1.5% in 2011 to 20.8% in 2018 according to the National Youth Tobacco Survey (NYTS) (Gentzke et al., 2019). In 2019, NYTS found that 27.5% of high schoolers and 10.5% of middle school students reported currently using ECIG products among 19,018 high school and middle school students (Gentzke, et al., 2019). Similarly, another national surveillance study found that from 2010-2020 ECIG current use had increased 0.3% to 3.7% among adults — over a 10-fold increase of current users in the span of 10 years (Adjaye-Gbewonyo & Boersma, 2021; Centers for Disease Control and Prevention, 2017; McMillen et al., 2014).

The rapid increase of ECIG use, also known as vaping, is concerning because the aerosol that is produced from ECIG use is known to contain toxicants, including but not limited to

aldehydes, heavy metals, volatile organic compounds (VOCs), and tobacco-specific nitrosamines (TSNAs) (Cheng, 2014; Li et al., 2020). Furthermore, chemical analyses of ECIG liquids that contain propylene glycol and vegetable glycerin produce pulmonary irritants and other carcinogenic carbonyls – including formaldehyde, acetaldehyde, and acrolein when heated (Cao et al., 2020).

Health Effects of ECIG Use

Persistent ECIG use and exposure to compounds found in ECIG aerosol has been associated with inflammation of various parts of the pulmonary system, including but not limited to the lungs, bronchial system, and trachea (Seiler-Ramadas et al., 2020). Gastrointestinal symptoms were also associated with ECIG use, these included epigastric pain, nausea, vomiting, diarrhea, and gastrointestinal hemorrhaging (Seiler-Ramadas et al., 2020). As with traditional cigarettes, the nicotine inhalation from ECIGs causes vasoconstriction, increased heart rate, and myocardial contractility (Pisinger & Døssing, 2014).

Chronic ECIG use and exposure to substances found in ECIG aerosol may also have long-term adverse effects on pulmonary and cardiovascular health, although more longitudinal evidence is required for a definitive statement (Lee et al., 2019; Li et al., 2020). There is no conclusive longitudinal evidence on the health effects of long-term ECIG use yet; however, there have been a multitude of reported cases of e-cigarette or vaping product use-associated lung injuries (EVALI) across the United States (Cao et al., 2020; Kaslow & Petrache, 2020). Since the first known reported cases of EVALI back in early 2019, there have been over 2500 reported cases of EVALI. The sudden outbreak of EVALI cases, heavily associated with vitamin E acetate (VEA) found in some ECIG devices, are responsible for at least 68 US deaths since 2020 (Wei et al., 2021, Belok et al., 2020). A follow-up of 23 adults that had been hospitalized for

EVALI has shown that most patients had significantly lower diffusion capacity (DLCO) (Wei et al., 2021). This not only suggests that there has been a decrease in functioning of alveolar units but also implies that EVALI cases can implicate persistent lung damage (Belok et al., 2020). Additionally, more research has found that EVALI has caused observable, perhaps chronic, pulmonary diseases such as organizing pneumonia, hypersensitivity pneumonitis, acute eosinophilic pneumonia, and diffuse alveolar damage (Kaslow & Petrache, 2020).

ECIG Awareness and Harm Perception

Harm perceptions are an individual's perceived risk or beliefs about potential harm and have influence on the decisions people make in life (Kong et al., 2019). For example, a person that has high harm perceptions of cigarette smoke (believes that cigarette smoke causes harm) may not smoke as many cigarettes as someone who reports lower harm perception (believes that cigarette smoke doesn't cause harm). Although positive harm perceptions of ECIGs vs traditional cigarettes has decreased recently, many people still perceive lower harm perceptions of ECIG products over traditional cigarettes which mean that there may be more vaping occurring around other people or in places where traditional cigarette use would be deemed inacceptable (Malt et al., 2020).

Despite data that suggests the harms of ECIG use and the unknown long-term consequences, there is still a prevalent perception of ECIGs being 'safe' or 'safer than other tobacco products' (Malt et al., 2020; Mattingly et al., 2021). Although there have been studies to show that ECIGs contain significantly fewer carcinogens than traditional combustible tobacco products, this general perception of ECIG devices as 'safe' is misplaced (Darabseh et al., 2020). This exaggerated perception of a 'healthy alternative' can be due in part to marketing efforts by ECIG companies that have suggested or directly stated that ECIGs only emitted water vapor,

which is not the case (Hart et al., 2017). Although adverts and marketing efforts like these promoting ECIG products are more regulated since ECIG devices were deemed tobacco products back in 2016 by the FDA, many people still perceive ECIGs to be safe (Hart et al., 2017; Wylie et al., 2021). In some instances, individuals who have reported never using any tobacco products before, associated ECIGs with increased health benefits (Copeland et al., 2017; Hart et al., 2017; Pokhrel et al., 2014). A survey study done in 2017 showed that ECIG users in college were more likely to report that vapor from ECIGs was safe to others (57.1% of current users in the study), and current users were less likely to label ECIG devices as 'tobacco products' and more likely to view them as healthy and safe choices (Hart et al., 2017). These reported harm perceptions are important in understanding relationships between health expectancies and health outcomes for future studies as current harm perceptions of ECIG devices versus traditional smoking products have subsequent implications on public health.

ECIG Use in Indoor Settings

With the increase in ECIG use there has also been an increase in people vaping in indoor areas, public spaces, and vehicles; this may be in part due to a normative acceptance of vaping or a lack of knowledge in the consequences of secondhand exposure and thirdhand exposures to ECIG devices (Mello et al., 2015; Trumbo & Harper, 2015). Public spaces, especially those that are indoors, and small enclosed spaces such as personal vehicles are susceptible to elevated levels of particulate matter (PM) in the ambient atmosphere while vaping is actively occurring. In a recent study, the presence of fine PM increased 125-330 times in a vaping convention where active ECIG use was occurring compared to the same room when no ECIG use was occurring (Soule et al., 2016). The implications of this study are worrying because a common place for ECIG use is in cars and vehicles (Drehmer et al., 2019); within a much smaller space, the

concentration for PM may be much higher than in an indoor space such as the one examined in the study.

The common perception of ECIG safety and low harm perceptions, may have caused an increase in people vaping around other people in public but also around people in a private setting as well (in vehicles, at home, etc.) comparatively to other traditional combustible tobacco products (Drehmer et al., 2019; Lee et al., 2019; Li et al., 2020). That is, while many people avoid smoking cigarettes or cigars in indoor settings, ECIG use indoors in the presence of bystanders may be more common. This behavior can lead to more people being exposed to secondhand and thirdhand ECIG aerosol. Secondhand exposure is characterized as the inhalation of a mixture of toxic compounds that have resulted from the combustion of tobacco or atomized aerosols (Czogala et al., 2014); while thirdhand smoking exposure is characterized as exposure to residuals from tobacco smoke/ECIG aerosols that have deposited onto surfaces but also through other pathways as aerosolization, evaporation, and conversion to other secondary toxic chemicals (Son et al., 2020). In a recent study, vape shops were used to test the amounts and compositions of these secondhand and thirdhand exposures. There was a significant increase of PM that contained nicotine and harmful aldehydes (formaldehyde and acetaldehyde) in the air during open hours of the shop compared to the closing hours (Son et al., 2020). These findings suggest that non-smokers may be exposed to these pulmonary irritants and toxicants by being in the presence of active ECIG use in an indoor area. Additionally, the study also explored thirdhand exposures by measuring the composition of surface deposition in the same vape shops. Thirdhand exposure analysis showed that there were significant amounts of carcinogenic TSNAs (NNA and NNK) on the surfaces where active vaping had occurred, these TSNAs are a result of the nicotine deposited onto surfaces reacting with nitrous acid which is ubiquitous in the

atmosphere (Son et al., 2020). The nicotine levels observed on the surfaces in vape shops could be much higher than levels observed in cigarette smokers' cars and homes (Son et al., 2020), although vape shops may not represent typical exposures for the average ECIG users' car or home. Both TSNAs observed, 4-(methylnitrosamino)-4-(3-pyridyl)butanal (NNA) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) are known carcinogens (Brown et al., 2003; Hecht & Tricker, 1999). While the literature for longitudinal health effects to these exposures is limited, the current research on analyzing aerosol residue composition as well as amounts of aerosol residue that is deposited by ECIG devices may shed light onto the implication and later health effects of secondhand and thirdhand exposures.

For those who may not want to actively inhale these ECIG aerosols, the common behavior of indoor ECIG use represents a concern: in the presence of those who are using ECIG devices, there may be inherent involuntary exposure due to proximity. To mitigate this unwanted secondary exposure, many US states and municipalities have begun implementing clean-air policies and other smoke-free laws (Tatalovich et al., 2017). However, many policies omit ECIG use for restrictions on indoor tobacco use. Additionally, policies in private settings, such as in homes or vehicles, may be challenging to impose or enforce.

Policy on ECIG Devices

As of July 2021, there are a total of 22,720 municipalities that are covered by 100% smoke-free provisions within non-hospitality workplaces, restaurants, or bars by law (American Nonsmokers' Rights Foundation, 2021). However, there are still 23 US states without any statewide comprehensive smoke-free law or prohibition of indoor ECIG use (Centers for Disease Control and Prevention, 2021). A recent study explored whether these indoor smoke-free policies affected ECIG user behavior in indoor places. The study found that although there was a

significant decrease in use in states with indoor smoke-free policy among the age group of 25-59 year-olds, however, the implementation of these policies did not significantly affect use behaviors among 18-24 year-olds (Lee et al., 2019). There is limited longitudinal data that suggests specific reasonings as to why there are age differences in the observance of smoke-free policies. However, a possible explanation is that the difference may be affected by young adults' indifference to policy or positive perception of ECIG devices over traditional tobacco products.

ECIG Devices and Vulnerable Populations

The reason age differences in likelihood of exposure to secondhand ECIG aerosol are important to understand and study is because the long-term effects of ECIG use are largely unknown. Additionally, studies have shown a possible correlation between youth ECIG use as a channel for initiation of traditional tobacco use such as cigarettes (Park et al., 2016; Spindle et al., 2016; Yoong et al., 2021). This is problematic because instead of a tool for smoking cessation, which early ECIG devices were marketed as, they are now devices endemic to the youth population who would not otherwise have used tobacco products (Park et al., 2016; Yoong et al., 2021). In fact, research has shown that although ECIG use may cause users to report fewer urges to smoke traditional cigarettes, however, they tend to become dual users who use traditional tobacco products (e.g., cigarettes) in addition to ECIG products (Hart et al., 2017). This coupled with the largely unknown long-term health effects of youth ECIG use poses a great public health concern now — as well as in the future when these chronic health outcomes may fully emerge. This highlights the importance of understanding ECIG use behaviors to identify groups that are most at-risk for engaging in ECIG use inside of vehicles in order to develop appropriated targeted interventions.

Study Purpose

Given that prior data suggest differences in ECIG use behaviors and perceptions based on age, there is a need to examine ECIG user harm perceptions and behaviors related to ECIG use inside of vehicles. The research that was conducted elaborates on the age differences in ECIG use behaviors observed in other studies, more specifically, the little data that is available on ECIG use and behavior within vehicles. The purpose of this study was to examine associations between age, ECIG use behaviors, and harm perceptions. There were four main research questions that were examined to explore associations between age and ECIG use in vehicles:

1. Is there an association between age and general harm perceptions of ECIG use and secondhand exposures in vehicles?
    i. Hypothesis: Older ECIG users will report greater harm perception of ECIG use and secondhand exposures in vehicles than younger ECIG users.
2. Is there an association between age and frequency of ECIG use in vehicles?
    ii. Hypothesis: Older ECIG users will report less frequent use of ECIG devices within vehicles than younger ECIG users.
3. Is there an association between age and reported vaping in vehicles while children are present?
    iii. Hypothesis: Older ECIG users will report less use of ECIG devices while there are children present in the car with them than younger ECIG users.
4. Is there an association between age and reported vaping in vehicles while other adults are present?
    iv. Hypothesis: Older ECIG users will report less use of ECIG devices while there are other adults present in the car with them than younger ECIG users.

The findings that come from this research could help inform policymakers on how to implement policies to mitigate youth ECIG use initiation or help develop educational resources that could prevent ECIG use around vulnerable populations. Additionally, knowledge of various

reported behaviors gathered from different age groups could help inform the public on what populations are more vulnerable than others as well as help identify underlying social/medical implications of public ECIG use and ECIG use inside of vehicles.

Methods

Overview

This study involved administering an online survey (Appendix A) that collected data from ECIG users (n=1002) residing in the United States that were older than 18, spoke English, and reported current use of an ECIG device (ECIG use within the past 30 days). The sample population was made to include a diverse group of people by utilizing quotas to ensure that the data collected was not biased towards a certain population. Specifically, the quotas ensured that participants were approximately 50% men and 50% women with the inclusion of transgender and non-gender binary-identified participants; no more than 60% White participants, at least 15% Black/African American, and 25% other races; and at least 35% between the ages of 18-24. 1050 individuals completed the survey, however, 48 respondents indicated they were ‘current’ ECIG users but did not report ECIG use within the past 30 days (did not meet the criteria for the study).

Survey Development

The survey was developed by reviewing previously validated survey items from various sources including the National Youth Tobacco Survey, the National Adult Tobacco Survey, the Health Styles Survey (Tobacco Use Supplement), Population Assessment of Tobacco and Health, National Health Information Survey, Monitoring the Future Survey, Global Adult Tobacco Survey, and Global Youth Tobacco Survey.Additional items were developed

specifically addressing ECIG and other tobacco use behaviors inside of vehicles. The survey was tested via cognitive interviews, a common way to empirically examine questionnaire items by recording and analyzing respondent mental processes and feedback of cognitive interviewees. Cognitive interviews help to identify potential biases in items, identify poorly phrased or poorly presented items, and attempt to increase participant comprehension of the items being inquired about. There were 5 separate cognitive interviews that took place to examine the survey. The cognitive interviews that were conducted included a think-aloud approach where the interviewees were asked to walk through what they were thinking about aloud on each item with an investigator who took field notes to assess item effectiveness. From there, survey questions were revised based upon the cognitive interview responses. The finalized survey was submitted to the East Carolina University and Medical Center Institution Review Board for approval and then to Qualtrics, a web-based survey tool that conducts data collection, evaluations, and surveys for analysis.

Study participants were asked to fill out the 103-item questionnaire that included items examining demographic information, tobacco product use behaviors, and tobacco product use perceptions. The demographic questions included items inquiring about race, ethnicity, age, gender, and their highest level of education. The questionnaire also included items about tobacco product use behaviors (e.g., whether they vaped around other people, frequency of use, device type, cleaning habits, preferred flavors, etc.) most of the responses were measured by nominal scales that asked about the frequency of reported behavior (i.e., “never,” “rarely,” “sometimes,” “almost always”/”always”). To examine ECIG user behaviors within vehicles 3 questions were analyzed: *‘When you are in your personal vehicle, such as a vehicle that you or your family owns or leases, how often do you vape inside of the vehicle?’, ‘How often do you vape inside of*

vehicles when other ADULTS are present?', and *'How often do you vape inside of vehicles when CHILDREN are present?'.*

Additionally, there were questions that inquired around themes of user health perceptions of ECIGs, traditional cigarettes, and perceived harms of second-hand exposures. To examine user-perceived harm perceptions of ECIG vapors the survey included the question: '*Not including the smoke from cigarettes or other tobacco products, do you think that breathing vapor from others' vapes/e-cigarettes causes…*'. The responses were weighted on a nominal scale (i.e., "no harm," "little harm," "some harm," "a lot of harm," "I don't know").

Statistical Analysis

All responses were digitally cataloged into the SPSS 26.0 statistical software. In SPSS, participant age was coded into 4 bins based on previous Center for Disease Control and Prevention's National Center for Health Statistics reporting ECIG prevalence among the US population (Villarroel et al., 2020). These 4 'age bins' were defined as 18-24, 25-44, 45-64, and 65+.

Harm perceptions were categorized into three groups for analysis (i.e., "No Harm", "Little Harm," "Some Harm," "A lot of Harm"). Due to qualitative similarities between both the "No Harm" and "Little Harm" response, these variables were recoded to "Little or No Harm" to increase the interpretability of the data. Only respondents who reported owning or leasing a personal vehicle and those reported having a harm perception were analyzed for the current analysis. For those variables that inquire about vaping around other people, only respondents who reported driving with those people were analyzed. That is, if a respondent didn't drive with children in their vehicle and reported never vaping around children, they would not be analyzed. After reorganizing the data and compiling the variables that were going to be analyzed,

descriptive statistics and chi-square tests of association were conducted. P-values were reported and differences were determined to be significant at an alpha-value of p = .05. Post-hoc z-tests were conducted on all variables that had significant association to determine significant differences between various age groups.

Results

Participant Characteristics

Among all participants (n=1002), 50.4% (n=505) were women, 59.9% (n=600) were White/European American, and the mean age was 32.8 years old (SD=12.8). Participants were organized into three age groups (18-24, 25-44, 45-64, and 65+) with those bin sizes being 34.9%, 47.2%, 15.8%, and 2.1%, respectively. Table 1 displays demographic information of participants that were analyzed.

User-Reported Harm Perceptions

The majority of participants analyzed (55.0%) reported perceiving 'Little or No Harm' from secondhand ECIG exposures. Age was significantly associated with reported harm perceptions of secondhand aerosols produced by ECIG devices (χ^2 (6, 919) = 26.1, $p < .001$). Specifically, a smaller percentage of 18-24 year-olds reported 'Little or No Harm' relative to all other age groups and greater percentage of 18-24 year-olds reported 'Some Harm' relative to all other age groups (See Table 2 and Figure 1). There were no significant differences between age groups for those that reported 'A lot of Harm'. The frequency of participants who reported having 'Little or No Harm' perceptions of secondhand ECIG aerosols increased as age increased — 44.5%, 59.5%, 61.8%, and 78.9 % respectively. Additionally, 18-24 year-olds had the highest proportion (10.4%) within their age group to report 'A lot of Harm' when asked about their harm

perceptions of secondhand ECIG vapor. Table 2 and Figure 1 displays information on harm perceptions by age group.

Frequency of ECIG Use within Vehicles

Among those who reported having a vehicle (n=971), 44.9% reported 'Almost Always', 35.9% reported 'Sometimes', 11.2% reported 'Rarely', and 7.9% reported 'Never' vaping when inside of personal vehicles. There was a significant association between age and frequency of use while in a personal vehicle (χ^2 (9, 971) = 21.5, p = .011). Among those who owned a personal vehicle, 18-24 year-olds were less likely to report 'Almost Always' vaping inside their vehicle relative to 25-44 year-olds. Conversely, more 18-24 year-olds reported 'Never' vaping in their own vehicle relative to 25-44 year-olds. The largest proportion of users that reported 'Almost Always' vaping inside of their vehicles came from the 25-44 age group (48.9%). 18-24 year-olds represented the age group that had the greatest percentage who reported 'Rarely' vaping while inside of personal vehicles. Proportion of respondents that reported 'Rarely' vaping inside of vehicles decreased as age increased. That is, 14.5% of 18-24 year-olds, 9.7% of 25-44 year-olds, 9.2% of 45-64 year-olds, and 5.0% of 65+ year-olds reporting 'Rarely' vaping inside of personal vehicles. Table 3 and Figure 2 displays information on frequency of use within personal vehicles by age group.

Frequency of ECIG Use within Vehicles around Adults

The frequency of use around other adults in vehicles was analyzed to measure ECIG use behaviors within vehicles, only adults who reported riding in a vehicle while adults were present were considered. Respondents were most likely to report 'Sometimes' vaping around other adults when in a vehicle. The frequency among those who reported 'Sometimes' vaping around

other adults increased with age — 32.4%, 44.3%, 44.6%, and 50.0% respectively. There was a significant association between age and frequency of use within personal vehicles around other adults (χ^2 (9, 953) = 35.9, $p < .001$). Results indicate that among those who rode in a vehicle while adults were present (n=971), 25-44 year-olds were more likely to vape around other adults than 18-24 year-olds. Across all age groups, 'Sometimes' vaping in their vehicles in the presence of other adults was the most common frequency, with 65+ year-olds having the greatest percentage reporting 'Sometimes' vaping around other adults across age groups (50.0%). The largest proportion of participants that reported 'Never' vaping around other adults when inside personal vehicles were 18-24 year-olds. Among the 18-24 year-olds, 25.0% reported 'Never' vaping around other adults. Conversely, the largest proportion within their age group to respond having 'Always' vaping when other adults were present was the 25-44 year-olds. Among 25-44 year-olds, 25.7% reported 'Always' vaping around other adults when inside of a personal vehicle. Table 4 and Figure 3 display information on frequency of ECIG use around other adults when inside of personal vehicles.

Frequency of ECIG Use within Vehicles around Children

Vaping frequency around children in personal vehicles was also analyzed to measure ECIG user behavior within vehicles, only adults who reported riding in a vehicle while children were present were considered (n=953). The majority (61.9%) of respondents who owned a vehicle and drive with children in their vehicle report 'Never' vaping inside of their vehicles when there are children present. A greater portion of respondent reported 'Never' vaping around children (61.9%) compared relative to 'Never' vaping around other adults (18.2%). Results indicated that 18-24 year-olds reported less ECIG use around children while middle-aged respondents reported more ECIG use around children. There was a significant association

between age and ECIG use frequency in vehicles when children were present (χ^2 (9, 863) = 22.8, p = .007). The largest proportion of those who report 'Never' vaping inside of a vehicle when children are present are the 18-24 year-olds (69.6%) whereas 25-44 year-olds were the lowest proportion of those who reported 'Never' vaping around children at 55.6%. Conversely, 25-44 year-olds were the most likely to report 'Always' vaping around children inside of their vehicles with 12.4% of 25-44 year-olds reporting 'Always' vaping around children in their vehicles. Table 5 and Figure 4 displays information on frequency of ECIG use around children inside of personal vehicles.

Discussion

This study examined differences of age groups' harm perceptions of secondhand aerosols in vehicles as well as their respective ECIG use behaviors, especially as they pertain to use inside of vehicles. Harm perceptions reported in this study had surprising trends among age groups. For example, as age increased, the proportion of respondents in each age group reporting 'Little or No Harm' decreased. The opposite is true for those reporting 'Some Harm'. Although there were no definitive, significant correlation in ECIG use frequency within personal vehicles and age, there were general trends that suggested the youngest age group was the least likely to vape inside their own vehicles and middle aged adults (25-44 year-olds) being the group that vaped the most often in their vehicles. Additionally, two other measures were assessed to examine ECIG use behaviors: frequency of use around other adults and frequency of use around children while in a vehicle. For both of these variables, the group that reported highest use frequency around others were the 25-44 year-olds. The youngest age group (18-24) also reported having some of the lowest ECIG use frequencies among all other age groups around other people.

Surprisingly, 18-24 year-olds had harm perceptions that would be associated with lower use rates when comparing to other age groups analyzed despite being the age group that is known to have the largest use rates in the US. Although there were no significant differences between age groups for those who reported ‘A lot of Harm’, 18-24 year-olds significantly differed from all other age groups for reporting ‘Little or No Harm’ less and ‘Some Harm’ more. This is surprising because other research suggests that lower harm perceptions would be associated with higher use rates and vice versa (Mattingly et al., 2021; Choi & Forster, 2013). However, these data do correlate with the lower use rates reported in vehicles and around others exhibited by the 18-24 year-olds in this study. A reoccurring pattern found in the current study was the significant differences between 18-24 year-olds and 25-44 year-olds regarding harm perceptions, frequency of reported ECIG use in personal vehicles, and frequency of reported ECIG use around children and adults. The most common post hoc significant differences in the study among all age groups came between the 18-24 and 25-44 age group between all variables. In our data, it was common to find 18-24 year-olds significantly reporting lower frequencies and higher harm perceptions of ECIG use comparative to the 25-44 year-olds. This suggests that there may need to be more public health campaigns that focus on the middle-aged adult demographic to mitigate ECIG usage not only for the personal health outcomes of the user but also to the people they may be around especially as it pertains to personal vehicles or other private spaces.

Historically, anti-vaping campaigns have largely targeted younger adults and youth audiences as they have had the highest prevalence of use (Duke et al., 2018). However, our data suggest that ECIG use in indoor spaces, such as a personal vehicles, may be the most prevalent in middle-aged demographics such as 25-44 year-olds. Our data suggest that younger ECIG users

may have higher harm perceptions regarding secondhand ECIG exposures. This could suggest the success of these anti-vaping campaigns to the younger audience. If that is the case, these campaigns should be translated to better suit those age groups that have been identified in this study with the lowest harm perceptions and the highest frequency of use rates to better address ECIG use in the US. In fact, a recent study has shown that parents may have gaps in comprehension of what ECIG devices are and what harms they can pose to their children. A recent study had shown that while 60.6% of parents reported concern over adolescent ECIG use, only 32.9% reported concern over their own child's ECIG use (Patel et al, 2019). Although it is essential to target youth populations to prevent onset of adolescent ECIG use, it is also important that we educate older generations on the public health concerns of chronic ECIG use as well. A recent study had shown that younger participants were more likely to use their parent's or older relative's ECIG device than older participants to have their own device (Alexander et al., 2019). The same study also found that many of the participants' ECIG use onset came from those devices acquired from older relatives/parents. This study suggests the attitudes and behaviors of older family members/parents may be influential in the onset of new ECIG users. Additionally, middle aged adults may be more likely to put children at risk. That is, middle-aged adults may be parents with younger children and therefore may be exposing children to ECIG aerosol. The literature as well as the data found in this study support the need for inclusion of these older generations in anti-vaping campaigns to help mitigate ECIG use (especially in indoor settings) in the US to prevent additional harm to ECIG users and the people around them.

The implications for vaping within a vehicle are also worrying due to the potential negative health effects. Recent reports found that within indoor spaces, it is more likely that a person will be exposed to greater levels of secondhand and thirdhand exposures that may be

caused by ECIG use compared to outdoor settings (Soule et al., 2016; Son et al., 2020; Schober et al., 2019). ECIG use in personal vehicles may present additional risks: vehicles represent a small, enclosed space where particulate matter concentration can increase with a few orders of magnitude when active vaping is occurring thus exposing passengers to possibly harmful or carcinogenic compounds. Even when active vaping is not occurring, the upholstery and surfaces of a vehicle can absorb compounds found in ECIG aerosols which can naturally react with the air to form carcinogenic compounds. Although this phenomena has not been specifically characterized or observed for a vehicular setting in the literature, it can be assumed it would happen the same as has been documented in other natural indoor settings (Son et al., 2020).

This study has several limitations. The data collected was based solely upon self-reported behaviors collected through an online survey. Although respondents were asked to answer as truthfully as possible there may be discrepancies between self-reported behavior and actual behavior due to perceived stigmas of responses or human error on reporting personal behaviors. However, cognitive testing for the survey and receiving positive feedback from participants tried to control for this. The stratified sampling among current ECIG users used to gather the participants of this study was to examine the associations between reported ECIG use behaviors and sociodemographic factors. Thus, the data collected may not truly represent a national population and the data must not be used to make generalizations of a population's behavior or overall perceptions that were measured in this study. There was a low number of participants who were 65+ years of age (n=21) compared to other groups. The low sample size for this group decreased the ability to detect difference between groups. To measure ECIG user behavior and harm perceptions only a few metrics were used to examine and generalize 'user behavior' and user 'harm perceptions', to enhance study validity more items could specify specific attitudes

and more nuanced behaviors to properly judge these variables within the target populations. Lastly, the survey is a cross-sectional analysis of the given sample population. The survey did not measure perceptions or behaviors over time and future research can explore what affect that public communication or certain policies may have on the reported behavior and harm perceptions of ECIG users.

In conclusion, results of this study provide data that elaborate upon and add to the literature on ECIG use behaviors and perceptions. Future research could explore why these age differences exist, look into what communication methods prove the most effective in reducing middle-aged adult use frequency over time, or measure aerosol concentrations/chemical depositions of vehicle's ambient environment during active use and intravehicular surfaces after prolonged ECIG use. As discussed in this study, although adolescent populations have been reported to have the highest rates of use in the US in recent years, specific vaping habits/behaviors and perceptions of ECIG devices of various age groups should not be generalized from this statistic as certain beliefs and behaviors may vary between all ECIG users.

Tables

Table 1. Participants' demographics and ECIG use characteristics (n=1002).

Characteristic	N	%
Age (M, SD)	(32.8, 12.8)	
18-24	350	34.9
25-44	473	47.2
45-64	158	15.8
65+	21	2.1
Gender		
Man	472	47.1
Woman	505	50.4
Other	25	2.5
Ethnicity		
Not Hispanic/Latino	824	82.2
Race		
White/European American	600	59.9
Black/African American	206	20.6
Asian	70	7
American Indian/Alaskan Native	30	3
Native Hawaiian/Pacific Islander	11	1.1
More than one race	65	6.5
Unknown	20	2
Type of Device[a]		
Cig-a-like	28	2.8
Pod mod (e.g., Juul)	359	35.8
Box Mod	211	21.1
Disposable (e.g., Posh, Puffbar)	160	16
Other	244	24.4
Frequency of Use		
Everyday	618	61.7
Some Days	384	38.3
Reported Harm Perceptions		
No Harm	187	18.7
Little Harm	318	31.7
Some Harm	335	33.4
A lot of Harm	79	7.9

Note. [a] Indicates participants' most commonly used / preferred ECIG device.

Table 2. Participants' reported harm perceptions of secondhand aerosols produced from ECIG devices by age (n=919).

	Age Group					
Reported Harm Perception	18-24	25-44	45-64	65+	Total	$\chi^2(6)$
Little or No Harm						
N	145_a	256_b	89_b	15_b	505	26.1***
%	44.5	59.5	61.8	78.9	55	
Some Harm						
N	147_a	143_b	42_b	3_b	335	
%	45.1	33.3	29.2	15.8	36.5	
A lot of Harm						
N	34_a	31_a	13_a	1_a	79	
%	10.4	7.2	9	5.3	8.6	
Total (N)	326	430	144	19	919	

Note. Asterisk (*) indicates significant chi-square test (* $p < .05$. ** $p < .01$. *** $p < .001$). Each subscript letter denotes a subset of age categories whose column proportions do not differ significantly from each other at the $p = .05$ level.

Table 3. Participants' reported frequency of use within personal vehicles by age (n=971).

Reported Frequency of Use within Personal Vehicles	Age Group					
	18-24	25-44	45-64	65+	Total	$\chi^2(9)$
Never						
N	36_a	26_b	$11_{a,b}$	4_a	77	21.5*
%	10.7	5.6	7.2	20	7.9	
Rarely						
N	49_a	45_b	$14_{a,b}$	$1_{a,b}$	109	
%	14.5	9.7	9.2	5	11.2	
Sometimes						
N	113_a	$165_{a,b}$	65_b	$6_{a,b}$	349	
%	33.5	35.7	42.8	30	35.9	
Almost Always						
N	139_a	226_b	$62_{a,b}$	$9_{a,b}$	436	
%	41.2	48.9	40.8	45	44.9	
Total (N)	337	462	152	20	971	

Note. Asterisk (*) indicates significant chi-square test (* $p < .05$. ** $p < .01$. *** $p < .001$). Each subscript letter denotes a subset of age categories whose column proportions do not differ significantly from each other at the $p = .05$ level.

Table 4. Participants' reported frequency of use around adults within personal vehicles by age (n=953).

Reported Frequency of Use Around Adults within Vehicles	Age Group					$\chi^2(9)$
	18-24	25-44	45-64	65+	Total	
Never						
N	81_a	60_b	$28_{a,b}$	$4_{a,b}$	173	35.9***
%	25	13	18.9	22.2	18.2	
Rarely						
N	72_a	79_a	34_a	2_a	187	
%	22.2	17.1	23	11.1	19.6	
Sometimes						
N	105_a	205_b	66_b	$9_{a,b}$	385	
%	32.4	44.3	44.6	50	40.4	
Always						
N	$66_{a,b}$	119_b	20_a	$3_{a,b}$	208	
%	20.4	25.7	13.5	16.7	21.8	
Total (N)	324	463	148	18	953	

Note. Asterisk (*) indicates significant chi-square test (* $p < .05$. ** $p < .01$. *** $p < .001$). Each subscript letter denotes a subset of age categories whose column proportions do not differ significantly from each other at the $p = .05$ level.

Table 5. Participants' reported frequency of use around children within personal vehicles by age (n=863).

Reported Frequency of Use Around Children within Vehicles	Age Group					$\chi^2(9)$
	18-24	25-44	45-64	65+	Total	
Never						
N	204_a	237_b	$83_{a,b}$	$10_{a,b}$	534	22.8**
%	69.6	55.6	64.3	66.7	61.9	
Rarely						
N	43_a	74_a	26_a	1_a	144	
%	14.7	17.4	20.2	6.7	16.7	
Sometimes						
N	28_a	62_b	$12_{a,b}$	$3_{a,b}$	105	
%	9.6	14.6	9.3	20	12.2	
Always						
N	18_a	53_b	8_a	$1_{a,b}$	80	
%	6.1	12.4	6.2	6.7	9.3	
Total (N)	293	426	129	15	863	

Note. Asterisk (*) indicates significant chi-square test (* $p < .05$. ** $p < .01$. *** $p < .001$). Each subscript letter denotes a subset of age categories whose column proportions do not differ significantly from each other at the $p = .05$ level.

Figures

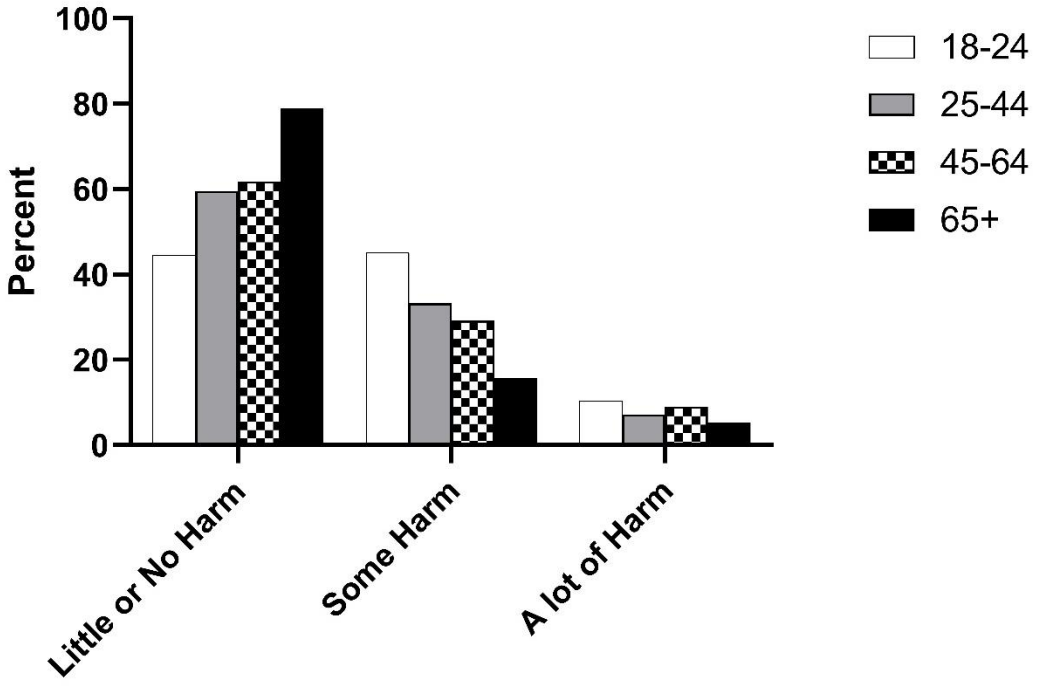

Figure 1. Reported harm perceptions of secondhand ECIG exposure. This figure illustrates the reported harm perceptions clustered by the proportion of respondents in their respective age groups for each harm perception (n=919).

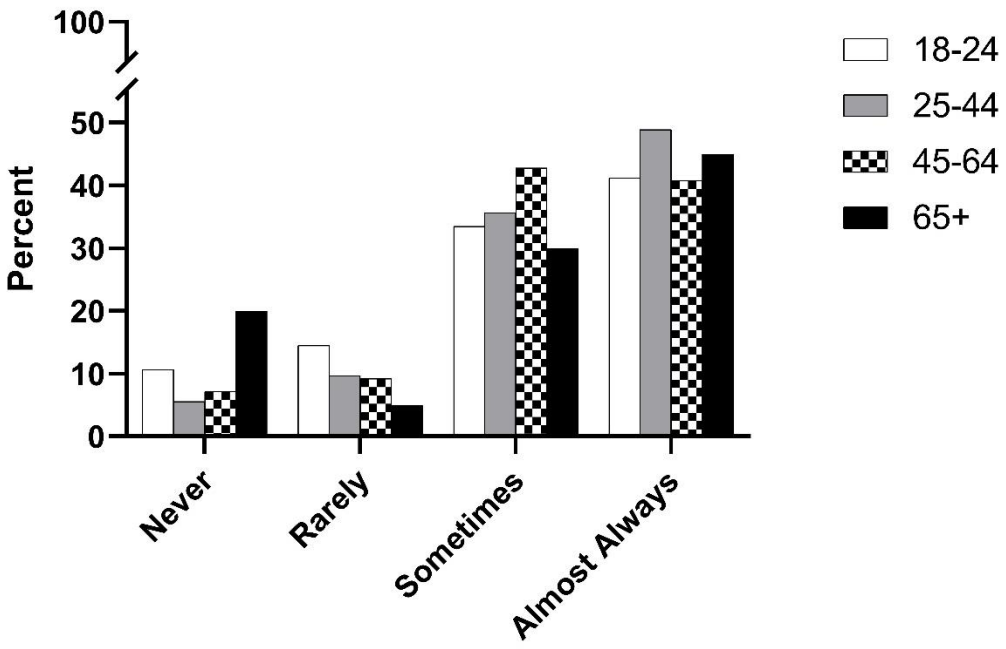

Figure 2. Reported vaping frequencies of those who have a personal vehicle. This figure illustrates the reported vaping frequency clustered by the proportion of respondents in their respective age group for each frequency. Participants analyzed reported owning/leasing the vehicle that they drive (n=971).

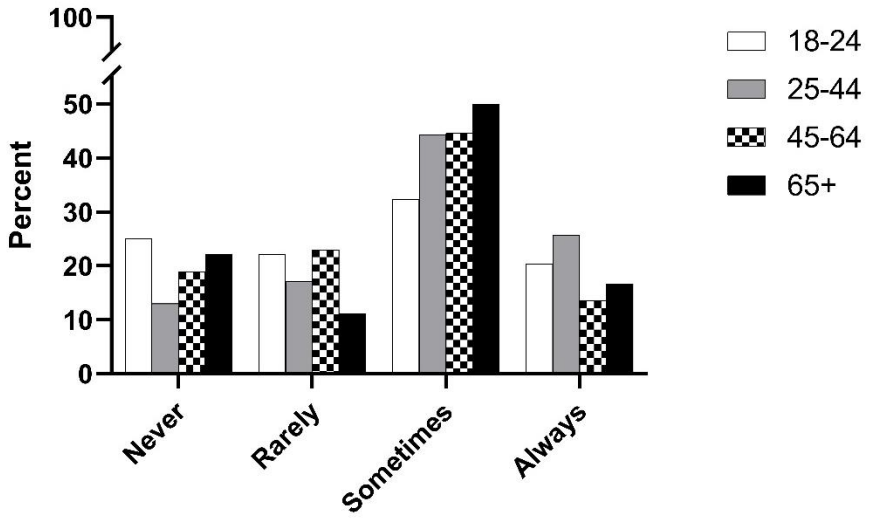

Figure 3. Reported vaping frequencies around other adults. This figure illustrates the reported vaping frequency around other adults clustered by the proportion of respondents from their respective age group for each frequency. Participants analyzed reported riding in a vehicle when other adults were present (n=953).

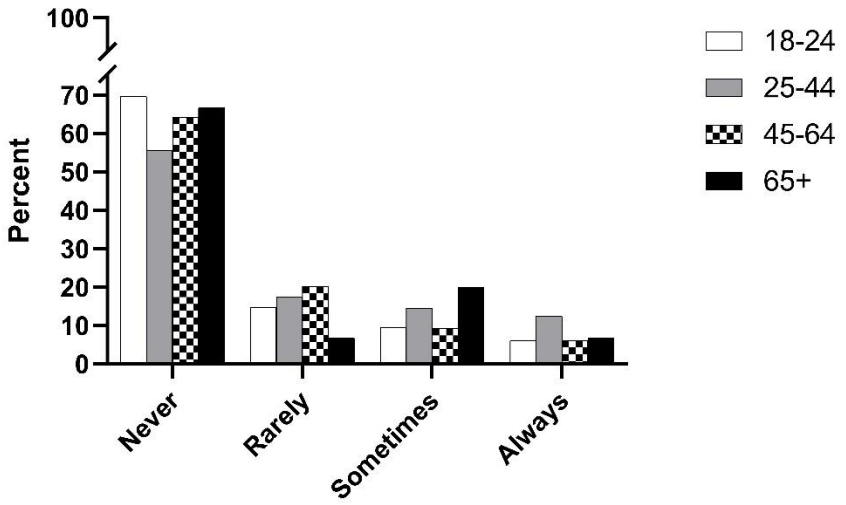

Figure 4. Reported vaping frequencies around children. This figure illustrates the reported vaping frequency around children clustered by the proportion of respondents from their respective age group for each frequency. Participants analyzed reported riding in a vehicle while children were present (n=863).

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Appendix A

Vaping Inside Vehicles Assessment Study Survey

What is your ethnicity?

- (1) Hispanic/Latino(a)
- (0) Not Hispanic/Latino(a)

Which of the following best describes your race?

- (1) American Indian/Alaskan Native
- (2) Asian
- (3) Native Hawaiian/Pacific Islander
- (4) Black/African American
- (5) White/European American
- (6) More than one race
- (7) I prefer not to answer

Which of the following best describes you?

- (1) Woman
- (2) Man
- (3) Transgender man
- (4) Transgender woman
- (5) Non-binary/ gender non-conforming
- (6) A different identify (please describe)_____

What is your age (in years)?

[Free response]

What is the highest degree or level of school you have completed?

- (1) No schooling completed
- (2) Nursery school to 8th grade
- (3) 9th, 10th, or 11th grade
- (4) 12th grade, no diploma
- (5) High school graduate with high school diploma
- (6) GED (general education diploma)
- (7) Some college credit, but less than 1 year

- (8) 1 or more years of college, no degree
- (9) Associate's degree
- (10) Bachelor's degree
- (11) Master's degree
- (12) Professional degree (e.g., MD)
- (13) Doctorate degree

The next questions ask about your use of vapes/e-cigarette devices. There are many devices that we consider vapes/e-cigarette devices including first generation e-cigarette devices (like cig-alikes), vapes, mods, pod mods (such as JUUL), vape pens, disposable vapes, e-hookahs, etc. Please see the picture below for some examples of the devices that we consider vapes/e-cigarette devices.

Do you currently use a vape/e-cigarette device every day, some days, or not at all?

- (1) Every day
- (2) Some days
- (3) Not at all

Have you used a vape/e-cigarette device in the past 30 days?

- (1) Yes
- (0) No

How many days in the past 30 days have you used a vape/e-cigarette device?

[Free response]

Look at the picture below. Which of the following best describes your vape/e-cigarette device you use regularly?

- (1) 1 –Cig-alike
- (2) 2 – E-hookah
- (3) 3 – Vape pen/eGo style device
- (4) 4 – Box Mod or Rebuildable/Mechanical Mod
- (5) 5 – E-cigar
- (6) 6 – E-pipe
- (7) 7 – Pod mod such as JUUL or other similar device

- (8) 8 – Disposable vape such as a Posh, Puff Bar, Mojo, or other similar device
- (9) Some other device (please specify) _____

What is the name of the vape/e-cigarette device you use? If you don't know, please enter "Don't know"

[Free response]

Look at the picture below. Which of the following types of vapes/e-cigarette devices do you currently use? Please select all that apply.

- (1) 1 – Cig-alike
- (2) 2 – E-hookah
- (3) 3 – Vape pen/eGo style device
- (4) 4 – Box Mod or Rebuildable/Mechanical Mod
- (5) 5 – E-cigar
- (6) 6 – E-pipe
- (7) 7 – Pod mod such as JUUL or other similar device
- (8) 8 – Disposable vape such as a Posh, Puff Bar, Mojo, or other similar device

How many vapes/e-cigarette devices do you currently use?

[Free response]

How long have you vaped/used an e-cigarette device on a regular basis (e.g., every day or some days)?

- (1) I have never vaped on a a regular basis
- (2) Less than a month
- (3) 1-3 months
- (4) 4-6 months
- (5) 7-12 months
- (6) Between 1 and 2 years
- (7) More than 2 years

On average, when you used a vape/e-cigarette device during the past 30 days, about how often did you use it per day?

- (1) I did not use a vape/e-cigarette device in the past 30 days
- (2) At least once per day
- (3) Every once in a while throughout the day
- (4) Fairly frequently throughout the day
- (5) Almost always throughout the day

What is your preferred e-liquid nicotine concentration/strength that you use most often in your primary vape/e-cigarette device? Please answer in mg/ml or nicotine %.

- Exact mg/ml _____
- Nicotine % _____
- I don’t know

Which of the following is closest to your preferred PG/VG ratio (propylene glycol/ vegetable glycerin) for your e-liquid?

- 100 PG/ 0 VG
- 70 PG/ 30 VG
- 50 PG/ 50 VG
- 30 PG/ 70 VG
- 0 PG/ 100 VG
- I don't know

Do you use any other substances in your e-liquid besides nicotine such as CBD oil, THC oil, essential oils, or any other additives? Please select all that apply.

- CBD oil
- THC oil
- Essential oils
- Some other additive (list all that apply) _____
- I do not use any other additives in my e-liquid
- I don't know

Where do you get your e-liquid? If someone else gets your e-liquid for you, where do they get the e-liquid? (select all that apply)

- Vape shop/tobacco store
- Gas station or convenience store
- Retail store like a grocery store, drug store, or department store
- Order e-liquid online/over the internet
- Homemade/Do-it-yourself (DIY)
- Other _____

Which of the following best categorizes the e-liquid flavors (i.e., smell and taste) you used in the past 30 days? Please select all that apply.

- Menthol

- Mint
- Tobacco
- Clove, spice, nut
- Fruit
- Chocolate
- Vanilla or crème
- Alcoholic drink (such as margarita, strawberry daiquiri, wine, cognac, etc.)
- Coffee/tea
- Candy
- Desserts (such as ice cream, cake, cookies, etc.)
- Other _____
- I don’t use a flavor

What is the wattage that your vape/e-cigarette device operates at? Please answer in watts. If you use a variable wattage device, what wattage do you vape at most often.

- Watts _____[Free response]
- I don’t know

This section asks you about your VAPING/E-CIGARETTE use inside of VEHICLES.

When you are in your personal vehicle, such as a vehicle that you or your family owns or leases, how often do you vape *inside of the vehicle*?

- (1) Almost always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I/My family does not own or lease a vehicle

When you are in someone else's vehicle, such as a friend's vehicle, how often do you vape *inside of the vehicle*?

- (1) Almost always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I don't ride in other people's vehicles

How often do you vape inside of vehicles when other ADULTS are present?

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not drive or ride in vehicles when other adults are present
- (6) I do not vape when I am in vehicles

How often do you vape inside of vehicles when CHILDREN are present?

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not drive or ride in vehicles when children are present
- (6) I do not vape when I am in vehicles
- (7) I do not drive or ride in vehicles

Do you ever use a work vehicle as part of your job? This includes your personal vehicle if you use it for part of your job (e.g., Uber/Lyft driver, delivery service, etc.)

- (1) Yes
- (0) No

When you drive or ride in a work vehicle that you use as part of your job, how often do you vape *inside of the vehicle*?

- (1) Almost always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not drive/ride in a work vehicle
- (8) I don't know

When you vape inside of a vehicle, do you roll down/ open the windows in the vehicle?

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I don't vape inside of vehicles

When you vape inside of a vehicle, do you usually keep the window(s)…

- (1) Completely closed/ all the way up
- (2) Partially closed/ part of the way up
- (3) Completely open/ all the way down
- (4) I do not vape inside of vehicles
-

Besides rolling down the window, when you vape inside of a vehicle, what behaviors do you use to control the amount of vapor inside the vehicle? (Please check all that apply).

- Exhale the vapor out the window
- Exhale the vapor down or to the side
- Exhale the vapor away from me or other people in the vehicle
- Turn on air conditioning or air vents
- Take smaller puffs to make smaller clouds
- Hold vapor in longer so I exhale less vapor
- Use a vape/e-cigarette device and e-liquid that produces less vapor
- Something else (please describe) _____

- I don’t vape inside of vehicles

Which of the following situations do you vape in while you are the driver of a vehicle? Please check all that apply.

- (1) While driving and moving.
- (2) While in drive, but not moving (e.g. at stoplight or stop sign)
- (3) While parked.
- (4) I don’t vape inside of vehicles.
- (5) I don’t drive a vehicle

How often do you refill your vape/e-cigarette device while you are driving your vehicle? This includes refilling liquid or changing the pod or cartridge on your device.

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I don’t use a device that I can refill or change pods/cartridges
- (6) I don’t vape inside of vehicles
- (7) I don’t drive a vehicle

When you clean the inside of your vehicle, how do you clean? If someone else cleans your vehicle, please answer based on how they clean the inside of your vehicle. Please select all that apply.

- Vacuum the interior
- Wipe or wash the windows
- Wipe or wash the steering wheel
- Wipe or wash the dashboard or other surfaces
- Wipe or wash the seats/upholstery
- Use air fresheners or other sprays
- I clean my vehicle some other way (please describe) _____
- I/my family does not own or lease a vehicle

In general, which BEST describes how often do you or someone else clean/wash the interior surfaces of your vehicle?

- More than once per week
- Once every week
- Once every month
- Once every 2-5 months
- Once every 6-11 months
- Once every year or longer
- I never clean or wash the interior surfaces of my vehicle
- I/my family does not own or lease a vehicle

When you vape inside of a vehicle with others, how often do you share vapes/e-cigarette devices while you or someone else is driving?

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I don’t vape inside of vehicles

Are there any other behaviors related to vaping/e-cigarette use inside of a vehicle that you engage in? If yes, please describe them below.

[Free response]

This next section asks you about VAPING/E-CIGARETTE USE inside your HOME.

Not counting decks, porches, or garages, during a typical week, how many days do vape *inside of your home*?

- (0) 0 days
- (1) 1 day
- (2) 2 days
- (3) 3 days
- (4) 4 days
- (5) 5 days
- (6) 6 days
- (7) 7 days

This section asks you about your OPINIONS related to harms of secondhand vapor from VAPES/E-CIGARETTES.

Not including the smoke from cigarettes or other tobacco products, do you think that breathing vapor from others' vapes/e-cigarettes causes:

- (1) No harm
- (2) Little harm
- (3) Some harm
- (4) A lot of harm
- (8) I don't know

How do you think opening the windows inside of a vehicle affects the harm from secondhand vaping inside of a vehicle?

- (1) It decreases the harm a lot
- (2) It decreases the harm a little
- (3) It does not affect the harm
- (4) It increases the harm a little
- (4) It increases the harm a lot
- (8) I don't know

This section asks you about your OPINIONS about VAPES/E-CIGARETTES.

Which BEST describes your opinion about *vaping inside of a vehicle* when there are other ADULTS present? Vaping SHOULD…

- (1) Always be allowed
- (2) Be allowed under some conditions
- (3) Never be allowed

Which BEST describes your opinion about *vaping inside of a vehicle*, when there are CHILDREN present? Vaping SHOULD…

- (1) Always be allowed
- (2) Be allowed under some conditions
- (3) Never be allowed

Which BEST describes your opinion about *vaping in indoor public places* (e.g., stores, restaurants, movie theaters)? Vaping SHOULD …

- (1) Always be allowed/ allowed in ALL areas
- (2) Be allowed under some conditions/ allowed in SOME areas
- (3) Never be allowed/ not allowed at all

Which BEST describes your opinion about vaping in *indoor bars, cocktail lounges, and clubs*? Vaping SHOULD…

- (1) Always be allowed/ allowed in ALL areas
- (2) Be allowed under some conditions/ allowed in SOME areas
- (3) Never be allowed/ not allowed at all

Which BEST describes your opinion about *vaping inside indoor work areas*? Vaping SHOULD…

- (1) Always be allowed/ allowed in ALL areas
- (2) Be allowed under some conditions/ allowed in SOME areas
- (3) Never be allowed/ not allowed at all

This next section asks you about RULES related to VAPES/E-CIGARETTES.

Not counting motorcycles, which BEST describes the rules about vaping in the vehicle(s) that you or your family owns or leases? If you or your family do not own or lease your own vehicle, please answer based on the rules for the vehicles you ride in. Vaping is…

- (1) Always allowed
- (2) Sometimes allowed in at least one vehicle
- (3) Never allowed in any vehicle
- (8) I don't know

Which BEST describes the rules about vaping in the vehicles that you drive or ride in for your job? Vaping is…

- (1) Always allowed
- (2) Sometimes allowed
- (3) Never allowed
- (8) I don't know
- (4) I don't drive or ride in a work vehicle.

Not counting decks, porches, or garages, which BEST describes the rules about vaping inside your home? Vaping is…

- (1) Always allowed
- (2) Sometimes allowed/ allowed in some places
- (3) Never allowed
- (8) I don't know

Please answer the following questions based on your vaping experiences:

On the days that you vape, how soon after you wake up do you use your vape/e-cigarette device?

- Within 5 minutes
- 6-30 minutes
- 31-60 minutes
- After 60 minutes

Do you feel like you are addicted to vaping/using e-cigarettes?

- (1) Yes
- (0) No

I find myself reaching for my vape/e-cigarette device without thinking about it.

- (0) Never
- (1) Rarely
- (2) Sometimes
- (3) Often
- (4) Almost always

I drop everything to go out and buy vapes/e-cigarettes or e-juice.

- (0) Never
- (1) Rarely
- (2) Sometimes
- (3) Often
- (4) Almost always

I vape more before going into a situation where vaping is not allowed.

- (0) Never
- (1) Rarely
- (2) Sometimes
- (3) Often
- (4) Almost always

When I haven’t been able to vape for a few hours, the craving gets intolerable.

- (0) Never
- (1) Rarely

- (2) Sometimes
- (3) Often
- (4) Almost always

Since you started vaping, have you experienced any the following physical effects or respiratory symptoms from using your vape/e-cigarette device? Please check all that apply.

- Cough
- Chest pain
- Shortness of breath
- Abdominal pain
- Nausea
- Diarrhea
- Fever
- Chills
- Headache
- Weight loss
- I have not experienced any of these symptoms

This next section asks you about your use of other tobacco products.

Have you ever smoked a cigarette, even one or two puffs?

- (1) Yes
- (0) No

Have you smoked at least 100 cigarettes or more in your lifetime?

- (1) Yes
- (0) No

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

- (1) Not at all
- (2) Some days
- (3) Every day

On how many of the past 30 days did you smoke a cigarette?

[Free response – with validated response of a number between 0-30]

When you smoked during the past 30 days, about how many cigarettes did you smoke per day?

[Free response – with validated response of a number between 0 and 100]

In the past 30 days, did you usually smoke menthol or non-menthol cigarettes?

- Menthol
- Non-menthol
- No usual type
- I did not smoke cigarettes in the past 30 days

In the past 30 days, on the days that you smoked, how soon after you wake up do you smoke your first cigarette?

- Within 5 minutes
- 6-30 minutes
- 31-60 minutes
- After 60 minutes

- I did not smoke a cigarette in the past 30 days

Around this time 12 months ago, were you smoking cigarettes every day, some days or not at all?

- (1) Not at all
- (2) Some days
- (3) Every day

Around this time 12 months ago, on average, about how many cigarettes did you smoke per day on the days that you smoked?

[Free response]

During the past 30 days, did you smoke regular/large/premium cigars?

Large/Regular/Premium Cigars

- Yes
- No

During the past 30 days, did you smoke cigarillos/little cigars to smoke tobacco (e.g., Black and Mild's, Swisher Sweets Cigarillos, White Owl, and Garcia y Vega and Phillies Blunt**)?**

Cigarillos **Little Cigars**

- Yes
- No

During the past 30 days, did you use smokeless tobacco (e.g., chew, dip, snuff, snus)?

- Yes
- No

During the past 30 days, did you smoke tobacco using a hookah or waterpipe?

- Yes
- No

This section asks you about smoking CIGARETTES or other COMBUSTIBLE TOBACCO PRODUCTS inside of VEHICLES.

Not counting vaping, when you are your personal vehicle that you or your family owns or leases, how often do you smoke cigarettes or other tobacco products *inside of the vehicle*?

- (1) Almost always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not ever smoke cigarettes or other combustible tobacco products
- (8) I/my family does not own or lease a vehicle

When you are in someone else's vehicle, such as a friend's vehicle, how often do you smoke cigarettes or other tobacco products *inside of the vehicle*?

- (1) Almost always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not smoke cigarettes or other combustible tobacco products
- (6) I do not ride in other people's vehicles

How often do you smoke cigarettes or other tobacco products inside of vehicles when other ADULTS are present? Do you smoke…

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not drive or ride in vehicles when other adults are present
- (6) I do not smoke cigarettes or other combustible tobacco products

Which BEST describes your smoking behaviors inside of vehicle when CHILDREN are present? Do you smoke…

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I don't drive or ride in vehicles when children are present

- (6) I don't smoke cigarettes or other combustible tobacco products

When you drive or ride in a work vehicle that you use as part of your job, how often do you smoke cigarettes or other combustible tobacco products *inside of the vehicle*?

- (1) Almost always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not smoke cigarettes or other combustible tobacco products
- (6) I do not drive/ride in a work vehicle

When you smoke cigarettes or other combustible tobacco products inside of a vehicle, how often do you roll down/ open the windows in the vehicle?

- (1) Always
- (2) Sometimes
- (3) Rarely
- (4) Never
- (5) I do not smoke cigarettes or other combustible tobacco products
- (6) I do not drive/ride in vehicles

When you smoke cigarettes or other tobacco products inside of a vehicle, do you usually keep the window(s)…

- (1) Completely closed/ all the way up
- (2) Partially closed/ part of the way up
- (3) Completely open/ all the way down
- (4) I don't smoke inside of vehicles
- (5) I don't smoke cigarettes or other combustible tobacco products

Besides rolling down the window, when you smoke cigarettes or other tobacco products inside of a vehicle, what behaviors do you use to control the amount of smoke inside the vehicle? (Please check all that apply).

- Exhale the smoke out the window
- Exhale the smoke down or to the side
- Exhale the smoke away from me or other people in the vehicle
- Turn on air conditioning or air vents
- Take smaller puffs to make smaller amounts of smoke

- Hold the smoke in longer so I exhale less smoke
- Hold the cigarette/tobacco product out the window when I am not smoking
- Something else (please describe) _____
- I don’t smoke inside of vehicles

Which of the following situations do you smoke tobacco products in while you are the driver of a vehicle? Please check all that apply.

- (1) While driving and moving.
- (2) While in drive, but stopped (e.g. at a stoplight or stop sign).
- (3) While parked.
- (4) I don’t smoke inside of vehicles
- (5) I don’t smoke cigarettes or other combustible tobacco products

Are there any other behaviors related to smoking tobacco products inside of a vehicle that you engage in? If yes, please describe them below.

[Free response]

This next section asks you about smoking CIGARETTES or other COMBUSTIBLE TOBACCO PRODUCTS inside your HOME.

Not counting decks, porches, or garages, during a typical week, how many days do you smoke cigarettes or other tobacco products *inside of your home*?

- (0) 0 days
- (1) 1 day
- (2) 2 days
- (3) 3 days
- (4) 4 days
- (5) 5 days
- (6) 6 days
- (7) 7 days

This section asks you about your OPINIONS related to harms of secondhand smoke from CIGARETTES or other COMBUSTIBLE TOBACCO PRODUCTS.

Not including the vapor from vapes/e-cigarettes, do you think that breathing smoke from other people's cigarettes or other tobacco products causes:

- (1) No harm
- (2) Little harm
- (3) Some harm
- (4) A lot of harm
- (8) I don't know

How do you think opening the windows inside of a vehicle affects the harm from secondhand smoke from cigarettes or other tobacco products inside of a vehicle?

- (1) It decreases the harm a lot
- (2) It decreases the harm a little
- (3) It does not affect the harm
- (4) It increases the harm a little
- (4) It increases the harm a lot
- (8) I don't know

This section asks you about your OPINIONS about CIGARETTES and other COMBUSTIBLE TOBACCO PRODUCTS.

Which BEST describes your opinion about smoking cigarettes or other tobacco products *inside of a vehicle* when there are other ADULTS present? Smoking SHOULD…

- (1) Always be allowed
- (2) Be allowed under some conditions
- (3) Never be allowed

Which BEST describes your opinion about smoking cigarettes or other tobacco products *inside of a vehicle* when there are CHILDREN present? Smoking SHOULD…

- (1) Always be allowed
- (2) Be allowed under some conditions
- (3) Never be allowed

Which BEST describes your opinion about smoking cigarettes or other tobacco products *in indoor public places* (e.g., stores, restaurants, movie theaters)? Smoking SHOULD…

- (1) Always be allowed/ allowed in all areas
- (2) Be allowed under some conditions/ allowed in some areas
- (3) Never be allowed/ not allowed at all

Which BEST describes your opinion about smoking cigarettes or other tobacco products *in indoor bars, cocktail lounges, and clubs*? Smoking SHOULD…

- (1) Always be allowed/ allowed in all areas
- (2) Be allowed under some conditions/ allowed in some areas
- (3) Never be allowed/ not allowed at all

Which BEST describes your opinion about smoking cigarettes or other tobacco products *inside indoor work areas*? Smoking SHOULD…

- (1) Always be allowed/ allowed in ALL areas
- (2) Be allowed under some conditions/ allowed in SOME areas
- (3) Never be allowed/ not allowed at all

This next section asks you about RULES related to CIGARETTES and other COMBUSTIBLE TOBACCO PRODUCTS.

Not counting motorcycles, which BEST describes the rules about smoking cigarettes or other tobacco products in the vehicles that you or your family owns or leases? If you or your family do not own or lease your own vehicle, please answer based on the rules for the vehicles you ride in.

- (1) Always allowed
- (2) Sometimes allowed in at least one vehicle
- (3) Never allowed in any vehicle
- (8) I don't know

Which BEST describes the rules about smoking cigarettes or other tobacco products in the vehicles that you drive or ride in for your job? Smoking is…

- (1) Always allowed
- (2) Sometimes allowed
- (3) Never allowed
- (8) I don't know

Not counting decks, porches, or garages, which BEST describes the rules about smoking cigarettes or other tobacco products inside your home?

- (1) Always allowed
- (2) Sometimes allowed/ allowed in some places
- (3) Never allowed
- (8) I don't know

Appendix B

IRB Approval

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
rede.ecu.edu/umcirb/

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Eric Soule
CC:
Date: 3/30/2020
Re: UMCIRB 20-000824
Vaping inside of vehicles study

I am pleased to inform you that your research submission has been certified as exempt on 3/30/2020. This study is eligible for Exempt Certification under category # 2ab.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

Document	Description
Brief Description at Study Website(0.01)	Recruitment Documents/Scripts
Cognitive Interview Guide(0.01)	Interview/Focus Group Scripts/Questions
ECIG Car Screener.docx(0.01)	Data Collection Sheet
Exempt Information Sheet - ECIG Car Cognitive Interview.docx(0.01)	Consent Forms
Exempt Information Sheet - ECIG Car Quantitative Survey.docx(0.01)	Consent Forms
Exempt Information Sheet - Screener for ECIG Car Cognitive Interview .docx(0.01)	Consent Forms
Flyer(0.01)	Recruitment Documents/Scripts
Grant Application (Please refer to Aim 1 for the current study)(0.01)	Study Protocol or Grant Application
Quantitative Questionnaire ECIG Car.docx(0.01)	Data Collection Sheet
Quantitative Survey(0.01)	Surveys and Questionnaires
Quantitative Survey Participants will Review During Cognitive Interview(0.01)	Interview/Focus Group Scripts/Questions
Screening Survey for In-Person Cognitive Interviews(0.01)	Surveys and Questionnaires

For research studies where a waiver of HIPAA Authorization has been approved, each of the waiver criteria in 45 CFR 164.512(i)(2)(ii) has been met. Additionally, the elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418