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## Electronic Cigarettes: Addiction and Physiological Effects within Adolescents and Young Adults

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# **Electronic Cigarettes: Addiction and Physiological Effects within Adolescents and Young Adults**

## **Abstract**

In recent years, different organizations such as the American Cancer Society (ACS), the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO) have released statements and plans regarding the use of, and possible health risks of electronic cigarettes, also known as e-cigarettes, mods, vape pens, etc. Data released by the National Institute on Drug Abuse stated that teenagers in grades 8-12 are smoking e-cigarettes but have not smoked cigarettes before. In addition, 66% of those teenagers reported that the liquid they are smoking are “just flavoring” (NIH 2016).

According to the ACS, although electronic cigarettes are “less harmful” than smoking combustible cigarettes, its long-term effects are unknown. However, the CDC claims that use of e-cigarettes is unsafe for teenagers and young adults because the nicotine that is within the liquid is highly addictive and can harm adolescent brain development (CDC 2018).

There are many different types of electronic cigarettes, from pipes to cigars, to “tank” devices, but they all function similarly. The main components of an e-cigarette include a battery, heating element, and compartment to hold the vape liquid (Bratsis 2018). These parts work together to heat up the e-liquid in order for a person to inhale the vapor or mist into the user’s lungs. E-liquid usually contains nicotine and flavorings, but some brands can also contain marijuana. Therefore, the focus of this paper is to research and study the developmental and physiologic effects of habitual e-cigarette use within teenagers and young adults.

The author of this paper presented a quantitative descriptive research proposal where a survey was distributed to a group of college students who shared their experiences and perceptions about electronic cigarettes in relation to its health consequences.

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Electronic Cigarettes: Addiction and Physiological Effects within Adolescents and Young Adults

By

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Submitted in partial fulfillment of the requirements of the Bachelor of Science in Nursing  
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### **Abstract**

In recent years, different organizations such as the American Cancer Society (ACS), the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO) have released statements and plans regarding the use of, and possible health risks of electronic cigarettes, also known as e-cigarettes, mods, vape pens, etc. Data released by the National Institute on Drug Abuse stated that teenagers in grades 8-12 are smoking e-cigarettes but have not smoked cigarettes before. In addition, 66% of those teenagers reported that the liquid they are smoking are “just flavoring” (NIH 2016).

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There are many different types of electronic cigarettes, from pipes to cigars, to “tank” devices, but they all function similarly. The main components of an e-cigarette include a battery, heating element, and compartment to hold the vape liquid (Bratsis 2018). These parts work together to heat up the e-liquid in order for a person to inhale the vapor or mist into the user’s lungs. E-liquid usually contains nicotine and flavorings, but some brands can also contain marijuana. Therefore, the focus of this paper is to research and study the developmental and physiologic effects of habitual e-cigarette use within teenagers and young adults.

The author of this paper presented a quantitative descriptive research proposal where a survey was distributed to a group of college students who shared their experiences and perceptions about electronic cigarettes in relation to its health consequences.

## **Introduction**

Throughout grade school, to middle school, and to high school, everyone has been exposed to many activities and hobbies. Some hobbies range from sports and videogames, to other activities that are more “harmful.” For those of the older generation, cigarette use was a prominent habit within high school and college students (Office of Adolescent Health, 2016). Over the last decades, many different campaigns were run to combat the drug and smoking issue (HHS Office, and Public Affairs, 2018). Until recently, underage smoking (age 21) was at an all-time low. Unfortunately a new threat may be arising. In recent years, inhaling vapor from electronic cigarettes, otherwise known as “vaping” has been growing in popularity within the high school and college populations. Unlike cigarette smoking, there is not nearly as much research with the developmental and physiological effects of vaping on the lungs over a period of time. One area of research need is to tackle the question of whether vaping is as harmful as cigarette smoking, and if habitual use of e-cigarettes will lead to future substance abuse.

## **Problem Statement**

In recent years, organizations such as the American Cancer Society (ACS), the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO) have released statements and plans regarding the use of, and possible health risks of electronic cigarettes, also known as e-cigarettes, mods, vape pens, etc (CDC 2018). A statistic was released by the National Institute on Drug Abuse that adolescents (around ages 10-19) in grades 8-12 are smoking e-cigarettes but have not smoked cigarettes before. In addition, 66% of those teenagers reported that the liquid they were smoking was “just flavoring” (NIH 2016).

According to the ACS, although electronic cigarettes are “less harmful” than smoking combustible cigarettes, its long-term effects are unknown. However, the CDC claims that use of e-cigarettes is unsafe for teenagers and young adults because the nicotine that is within the liquid is highly addictive and can harm adolescent brain development (CDC, 2018).

There are many different types of electronic cigarettes, from pipes to cigars, to “tank” devices, and to looking very similar to Universal Serial Bus’s (USB), but they all function similarly. They work by converting liquid nicotine into a mist or vapor for the user to inhale. The main components of an e-cigarette include a battery, heating element, and compartment to hold the vape liquid (Bratsis, 2018). The combination of these parts function heats up the e-liquid in order for a person to inhale the vapor or mist into the their lungs. E-liquid usually contains nicotine and flavorings, but some brands can also contain marijuana. The focus of this paper is to propose a research study on the developmental and physiologic effects of habitual e-cigarette use within adolescents and young adults.

## **Research Question:**

What are the physiological effects of habitual e-cigarette use within adolescents and young adults, and how does it affect them developmentally?

### **Literature Review**

The articles for this literature review were selected for review with Dominican University of California's online library database "CIHNAL." These ten articles were found and selected with the keywords *e-cigarettes or electronic cigarettes or vapor cigarettes*. The research and findings that were conducted and found were performed in the years 2015-2018.

### **Composition**

Surprisingly, despite its prevalent use with adolescents, many do not even know what components are in their e-cigarette liquid. In the article *Metal Concentrations in E-Cigarette Liquid and Aerosol Samples: the Contribution of Metallic Coils*, researchers Olmedo, Goessler, Tanda, Grau-Perez, Jarmul and Aherrera (2018) took a look and investigate what metals transfer from the heating coil of an e-cigarette to the vape liquid in the e-cigarette tank. Few studies indicate that certain toxic metals such as chromium, nickel, and lead were found in the aerosol produced by e-cigarettes. The harmful health effects of this includes neurotoxicity (Garza et al. 2006) and cardiovascular disease (Navas-Acien et al. 2007), respiratory disease, and lung cancer. The goal of this study is to see if the heating coil in a e-cigarette contributes to toxic metal exposure during use. Analysis was used with a 15-metal panel in samples from different tank-style vapes collected from habitual e-cigarette users from Maryland. Samples included e-liquid from refilling dispenser, the tank after being used, and the generated aerosol. The researchers hypothesize higher metal concentrations in samples that have been in contact with the heating coil (aerosol and tank) compared with samples that have never been in contact with the coil (refilling dispenser). Comparisons were also made by the type of coil, device voltage, and

frequency of coil change (Olmedo, 2018). This study was composed of 56 participants who use tank-style devices and were recruited through vaping conventions and flyers posted in e-cigarette shops. Those who participated were instructed to bring their regular e-cigarette device and refilling dispenser on the day of the interview, and were provided informed consent. This study was approved by the institutional review board of the Johns Hopkins Bloomberg School of Public Health. In this study, trained field workers gave out a standardized questionnaire recording information on what brand of e-cigarette the participant uses, how much voltage is being used, type of coil, and frequency of coil change. Three types of samples were collected from their devices and dispensers. From here, an aerosol sample is collected for analysis, where a total of 49 samples were collected at room temperature. This study uses an internal standard and reference standard to ensure accuracy of results. Results from the analysis show that samples collected from tank-style devices of daily e-cigarettes had markedly higher concentrations of metals compared to samples collected from the tank and refilling dispenser. Some elements such as arsenic and lead were found in the dispensers (Olmedo, 2018). These metals have been associated with different health effects under chronic exposure. Lead is a major neurotoxicant both for children and aging populations and associated with increased risk of cardiovascular disease and kidney disease (Navas-Acien et al. 2007).

### **Addiction**

Leventhal, Stone, Andrabi, Barrington, Sussman, and Audrain McGovern (2016) conducted a study called *Association of E-Cigarette Vaping and Progression to Heavier Patterns of Cigarette Smoking*. The purpose of this study was to examine associations of vaping with subsequent smoking frequency and heaviness pattern among adolescents (Leventhal, 2018). This study included students from 10 different public high schools across Los Angeles,

California. Those who participated were involved in a longitudinal study and were given surveys during the fall and spring of their 10<sup>th</sup> grade year (2014-2015). Surveys were given to the high school students included questions that established different variables for analysis. These questions included asking past vaping habits within the past 30 days in order to establish a baseline. Other questions asked for smoking frequencies per day. After gathering their data, the researchers analyzed the data by using generalized estimating equation ordinal logistic regression models to assess association between baseline vaping and follow-up smoking habits using SAS Institute (Leventhal, 2016). Each model were retested after adjusting for several factors such as age, sex, ethnicity, highest parental education, living situation, use of alcohol or other drugs, family history of smoking, depressive symptoms, and use of any combustible tobacco products (Cronbach  $\alpha = .94$ ).

Results showed that despite prevalence rates of past 30 days of vaping and smoking were low overall, smoking and vaping frequency at follow-up was proportionately greater with successively higher levels of baseline vaping. Results also showed that there is a positive association between baseline vaping and follow-up smoking among baseline smokers. In conclusion, this study revealed that vaping is frequently is associated with a higher risk of habitual smoking 6 months later. One strength this study exhibited was that the testing model the researchers used accounted for several variables such age, sex, ethnicity, etc. One limitation of this study is that this study did not assess reason for vaping and the survey does not extend further beyond 6 months.

*In Assessing Nicotine Dependence in Adolescent E-Cigarette users: The 4-item Patient-Reported Outcomes Measurement Information System (PROMIS) Nicotine Dependence Item Bank for Electronic Cigarettes*, researchers Morean, Krishnan-Sarin, and O'Malley (2017) took a

look into assessing nicotine dependence in adolescent E-cigarette users. This study was approved by the Yale School of Medicine Institutional Review Board in 2017 to have high school students complete a 20-min, school-based, paper-and-pencil survey assessing tobacco product use (Morean, 2017). 2945 high school students participated in taking this survey. The survey given to the high school students composed of questions in a fixed order, where it asks the students questions about vaping before asking questions about other tobacco products.

In the survey, participants reported on sex, current grade in school, and race (Morean, 2017). Students were assessed when they started vaping using the question “How old were you when you first tried an e-cigarette, even just one or two puffs?” Other questions that were asked assessed past-month tobacco cigarette smoking and vaping frequency along with asking if the student vaped with nicotine in the past 30 days. If the student replies yes to smoking e-cigarettes with nicotine, concentration of nicotine (0, 3, 6, 12, 18, 24 mg) is asked. Around the middle of the survey, e-cigarette nicotine dependence was assessed using the 4-item PROMIS-E. This 4-item response survey asked further questions such as “I find myself reaching for my e-cigarette without thinking about it,” “I vape more before going into a situation where vaping is not allowed,” “When I haven’t been able to vape for a few hours, the craving gets intolerable,” and “I drop everything to go out and get e-cigarettes or e-juice.” Responses included: 0 (never), 1 (rarely), 2 (sometimes), 3 (often), and 4 (always).

Results showed that stronger nicotine dependence was associated with being in a higher grade, vaping at an earlier age, vaping more frequently, and using higher nicotine concentrations (Morean, 2017). In addition, results showed that e-cigarette nicotine dependence was also significantly associated with using nicotine e-liquid (Morean, 2017). From the data, it shows that nicotine dependence scores were higher among older adolescents, who smoked at an early

age, and are now smoking cigarettes (Morean, 2017). There was no significant finding indicating that either sex reported stronger nicotine dependence. Despite their findings, this research study met some limitations. Because the data collected were self-reported, it was up to the student taking the test to willingly and truthfully provide accurate answers. Furthermore, vape and cigarette use could not be confirmed due to the design study. This study stressed the importance of further research into relationships between sex, race, e-cigarette use frequency, and e-cigarette nicotine dependence.

Researchers Hongying Dai, Catley, Richter, Goggin, and Ellerbeck (2018) analyzed vaping and marijuana habits within the youth in their study *Electronic Cigarettes and Future Marijuana Use: A Longitudinal Study*. The researchers hypothesize that there might be an interaction between e-cigarette use and age in association with subsequent marijuana use (Hongying Dai, 2018). The first wave of data (wave 1) was collected by the researchers between September 2013 to December 2014 with 13,651 youth and 32,320 adults. The second wave (wave 2) of data was collected from October 2014 to October 2015 with 12,172 youth and 28,362 adults. Because the research team provided publicly available de-identified data, this study was determined to be nonhuman subjects research by the Children's Mercy Institutional Review Board (Hongying Dai, 2018). Youth ages 12-17 who never used marijuana were followed-up in 1 year.

Multivariable logistic regressions were performed to evaluate associations between e-cigarette use at wave 1 and ever/heavy marijuana use in the past 12 months and at wave 2 (Hongying Dai, 2018). All participants of the study were given a brief description and pictures of what e-cigarettes were and were asked the question, "Have you seen or heard of e-cigarettes before this study?" Those who responded yes were asked if they ever used one. Those who

responded “yes” were categorized as “e-cigarette ever users” at wave 1. In addition, users were asked the number of e-cigarettes and/or cartridges used in an entire life from 0 (no use) to 7(100 or more).

Researchers of this study used the Population Assessment of Tobacco and Health (PATH) survey to survey to examine associations of e-cigarette ever users at baseline (wave 1) with subsequent marijuana use 1 year later. Analysis was further stratified by different age groups to potentially enhance further understanding. Across all 11,996 participants between ages 12-17 years between wave 1 and 2 surveys, 1605 (13.4%) were considered ever users (Hongying Dai, 2018).

According to the data, never marijuana users tend to be younger and less likely to report using cigarettes, e-cigarettes, and other substances (Hongying Dai, 2018). Researchers discovered significant differences between e-cigarette never and ever users. Ever users were more likely than never users to be older, male, white, and have poorer grade performance (Hongying Dai, 2018). These results also revealed that they were more likely to report sensation seeking, smoking cigarettes, drinking, and ever nonmedical use of prescription drugs and using other illicit drugs.

In conclusion, Hongying Dai and the other researchers (2018) believe that e-cigarette use was associated with subsequent marijuana use, especially among those aged 12 to 14 years. Limitations exist for this research study. Baseline marijuana users were excluded from this analysis, there was a low prevalence of e-cigarette use at baseline. In addition, substance use were self-reported, indicating that reporting and recall biases might have occurred, especially for younger respondents. Another limitation of this study is that not all those who responded in wave 1 of the PATH study responded again in the wave 2 PATH survey. Lastly, PATH did not

ask those taking the survey about what substances the youth are vaping in their e-cigarettes.

Overall, the researchers urge and encourage others to continue investigating substance transition from nicotine to marijuana and evaluate long-term impacts of e-cigarette use, because according to the data, e-cigarette use was associated with an increased risk of subsequent marijuana use among the youth, with a stronger temporal association among younger adolescents (Hongyin Dai, 2018).

In a study analyzed in 2017, a group of researchers look among undergraduate college students who smoke substances other than nicotine in their e-cigarettes in the research article *The Use of Substances Other Than Nicotine in Electronic Cigarettes Among College Students. Substance Abuse: Research & Treatment*. Kenne, Fischbein, Tan, and Banks (2017) collected cross-sectional data from 1542 undergraduate college student e-cigarette users from a large Midwestern university via online surveys to assess prevalence of e-cigarette use, reasons for use, perceived harm, and prevalence and predictors of other substance use in e-cigarettes (OSUE).

The online anonymous survey given to the college students were sent via email and distributed to all students enrolled at a Midwestern University (n = 35 299) and 9494 responded (26.9% response rate). The email explained that the survey was regarding e-cigarettes. In addition, the email explained that it would take approximately 10 to 15 minutes to complete and participation in the survey qualified the respondent for a prize drawing that included 20 gift cards of varying denominations ranging from \$15 to \$50 each. After completion of the survey, those who wanted to enter the prize drawing were provided a link to a separate, online form where it requested the respondent's name and contact information. The survey was available for 8 days beginning January, 2014. The survey was designed to prevent those who participated to participate more than once or from forwarding the survey to others. This study only includes

undergraduate students from the main university campus (N = 5429) who reported lifetime use of e-cigarettes (N= 1542).

This study was approved by the university's Institutional Review Board. Questions in the survey included age, sex, race/ethnicity, class rank, Greek affiliation, home residency status (urban, rural, suburban), and international student status. Current tobacco smoking habits was assessed by asking if they were a current smoker, former smoker, or never smoker. Current or former smoker was defined as having smoked at least 100 cigarettes during his or her lifetime, and currently smokes every day or some days (current), or no longer smokes (former). Twenty three questions were asked regarding e-cigarette use, along with reasons for use, perceptions of harm (0=very safe, 7=very dangerous), and use of e-cigarettes to vape other substances ("Have you ever used or tried to use an e-cigarette to inhale another drug or substance other than nicotine?"). Participants were then asked to select from a list of drugs that they have used within the previous 30 days. Those who reported OSUE were presented with an open-ended question and asked to list each substance used in an e-cigarette.

After the data was collected, analysis was conducted using SPSS version 224 and SAS 9.3.25. Descriptive statistics were used to compute demographic information for all e-cigarette users combined, e-cigarette users reporting OSUE, and e-cigarette users not reporting OSUE (Kenne, 2017).

Results revealed that nearly 7% of reported users vaporize and inhale a substance other than nicotine (Kenne, 2017). Those who are current tobacco cigarette smokers were significantly more likely to report OSUE (51.0%) as compared with never (33.7%) and former (15.4%) smokers. Among those who reported OSUE, the primary reason for e-cigarette use was "safer than cigarettes" (21.7%), followed by "experimentation" (18.9%) and "friends use"

(17.0%) (Kenne, 2017). Around 77.9% of reported users reported using cannabis or some derivative of cannabis in an e-cigarette. Using binomial logistic regression, women were less likely to report OSUE by a factor of 0.60, former tobacco cigarette smokers as compared with never smokers were more likely to report OSUE by a factor of 1.87 and e-cigarette users who reported using e-cigarettes for “cool or trendy” reasons were more likely to report OSUE (Kenne, 2017). In conclusion, the researchers admitted that little is actually known regarding the health effects of cannabis and cannabis derivatives delivered through e-cigarettes. One finding Kenne and the other researchers acknowledged is the need for continued research regarding the vaping of cannabis and other illicit substances among college students. Because of this study, more discussion into why more younger adults are getting into vaping. To this group of college students, perception of smoking e-cigarettes is generally positive and many were willing to experiment with e-cigarettes. Part of the reason for this is due to the belief that e-cigarettes are less harmful than traditional cigarettes. In addition, studies indicate that individuals perceive the use of substances such as cannabis to be safer when vaporized versus combusted.

In 2018, Audrain-McGovern, Stone, Barrington-Trimis, Unger, and Leventhal examined whether use of e-cigarettes, hookah, or combustible cigarette use is associated with initiating and currently using marijuana and/or tobacco in their research article, *Adolescent E-Cigarette, Hookah, and Conventional Cigarette Use and Subsequent Marijuana Use: Pediatrics*. Data was collected by the researchers in part of a longitudinal survey of substance use and mental health among high school students in Los Angeles, California. Around 40 public high schools in the Los Angeles metropolitan area were approached about participating in this study where 10 schools agreed to participate in the study. These schools were chosen because of their diverse student population. To be involved in this study, students required parental written or verbal

assent and consent. The University of Southern California Institutional Review Board approved the study. Data collection involved 5 waves taken 6 months apart. Baseline starts at fall 2013 (9<sup>th</sup> grade), 6 month follow-up spring 2014 (9<sup>th</sup> grade), 12-month follow-up fall 2014 (10<sup>th</sup> grade), 18 month follow-up spring 2015 (10<sup>th</sup> grade), and 24 month follow-up fall 2015 (11<sup>th</sup> grade). Current use of all forms of marijuana was assessed at wave 5. During each wave, paper-and-pencil surveys were administered in students' classrooms, where any absent students completed an interviewer-administered phone survey or a web-based survey.

According to the results, the researchers discovered that the association between tobacco use and subsequent marijuana use across adolescence extends to multiple tobacco products (Audrian McGovern 2018). Baseline ever versus never e-cigarette use was associated with initiation and current marijuana use 24 months later (Audrian McGovern 2018). Ever versus never hookah use was associated with initiation and current marijuana use 24 months later (Audrian McGovern 2018). Similar associations were found for combustible cigarette smoking, initiation and current use of marijuana. Lastly, current use of any of these tobacco products as baseline was associated with current use of both tobacco and marijuana 24 months later.

In conclusion, findings indicate that association between tobacco use and subsequent marijuana use across adolescence extends to multiple tobacco products. From these findings, it is suggested that newer forms of tobacco likely increase adolescent vulnerability to marijuana use and dual use of marijuana and tobacco even in the context of other factors that are also correlated with marijuana use (Audrian McGovern 2018). From these findings, discussion can be brought up that the use of e-cigarettes and hookah may lead to adolescent marijuana use. This study has several strengths, one of them being that they had a demographically diverse sample that was measured during a developmental age of the students' lives. This study also uses

repeated measures of tobacco and marijuana initiation and current use, excluded adolescents who had ever used marijuana at baseline to clarify temporal precedence, and having high participation and retention rates. One limitation of this study is that the frequency of marijuana use was not measured. In addition, nothing more was assessed about e-cigarettes and hookahs beyond just use, such as flavoring.

In *Impact of E-Liquid Flavors on E-Cigarette Vaping Behavior, Drug & Alcohol Dependence*, Chu, St Helen, Benowitz, and Shahid (2018) had the objective of describing the impact of e-cigarette liquid flavors on experienced e-cigarette user's vaping behavior in a pilot study. This study was composed of a convenience sample of 3 females and 11 males (14 participants), who were recruited via Craigslist.com and flyers in neighborhoods, vape shops, and on college campuses. Criteria to be eligible to participate includes: exclusive e-cigarette use or dual use of fewer than five combustible tobacco cigarettes per day, use of second and/or third generation e-cigarettes on at least 25 days per month over the past three months or more, saliva cotinine level of at least 30 ng/ml, and expired carbon monoxide of 8 ppm or less. Of the participants, nine were white, three were mixed-race, and two were Asian. Those who are participating were asked to not smoke combustible cigarettes night before coming to the screening visit, because they were not to be allowed to smoke combustible cigarettes for the duration of the study. Exclusion criteria were also listed, which includes; unstable chronic medical conditions, current or past severe mental illness, currently pregnant, current illicit substance use other than cannabis, and people who only used first generation e-cigarettes.

This study was approved by the Institutional Review Board at the University of California San Francisco. Written, informed consent was obtained from all participants and all participants were financially compensated. The 13 participants engaged in a 3-day inpatient

crossover study using e-cigarette flavorings such as strawberry, tobacco, and other brand e-liquid. Nicotine levels were around in the 18 mg/mL in the strawberry flavoring and the tobacco e-liquids ranged between 3-18 mg/mL in the usual brands. Every day, participants had access to the study e-cigarette and the assigned e-liquid during a 90-minute videotaped ad libitum session. In this pilot study, the researchers conducted a three-arm crossover study on the effects of flavors on e-cigarette pharmacology in experienced users in the Clinical Research Center (CRC) research ward at Zuckerber San Francisco General Hospital. Every session for the three day study ran from 4 pm to 4 pm of the next day. During this time, participants could vape as much as they wanted to the e-liquid assigned for the next day to become acclimated to the e-liquid. Participants were then abstained from smoking overnight until the morning session of 15 puffs, followed by 4 more hours of smoking cessation, then finally a 90-minute ad libitum vape use session. After the 4 hours of smoking cessation following the 15 puff session, subjective questionnaires were given and blood samples were obtained from the participants every 15 min. Each e-cigarette tank was filled and weighed the same throughout every session. During the smoking session, participants were allowed to watch television, use the internet through a computer or smartphone, and/or read books. Participants were not allowed to sleep or doze off. The evaluation survey (Cigarette Evaluation Question) (mCEQ) was given to determine ratings (1-7) for each flavor, such as “taste good,” “not at all” to “extremely.” During the ad libitum sessions, participants were recorded using a high definition video camera that was positioned to capture the participant puffing on the e-cigarettee, any body movements. The participants were instructed to use the e-cigarette only when in full view of the camera. The average expired CO for all participants, nonsmokers, and dual users was  $2.7 \pm 1.4$  ppm,  $2.4 \pm 1.2$  ppm, and

4.5 ± 2.1 ppm (mean ± SD) (Chu 2018). According to the Penn State Electronic Cigarette Dependence Index, there is a medium dependence on e-cigarettes (Foulds et al., 2015).

In this pilot study, it was found that e-cigarette puff duration was longer with the strawberry flavoring compared to the tobacco flavoring. Participants took more puffs, longer puffs, and had shorter inter-puff intervals with their usual e-liquids compared to the two test e-liquids. In general, the participants tended to puff in larger groups of puffs (>10 puffs) with their brand e-liquids compared to the two test liquids and tobacco flavoring (1-5 puffs). However, vaping patterns did not differ significantly between the strawberry and tobacco e-liquids (Chu 2018).

The strength of the relationship between vaping topography, vaping patterns, and measures of nicotine intake and exposure were not consistent across e-liquids, likely due to the variability in nicotine content of the usual brand e-liquids. One goal of this study was to provide empirical evidence in user behavior with different flavorings of e-liquid. The participants tended to take longer puffs with the strawberry e-liquid compared to the tobacco e-liquid. A big limitation of this study is its small sample size, which may not be representative of the general U.S. population, and the sample size was majority male gender.

In the article *Trends and Substance Use Associations with E-Cigarette Use in US Adolescent, Clinical Pediatrics*, researchers Curran, Burk, Pitt and Middleman (2018) performed a secondary data analysis on the National Youth Risk Behavior Survey (NYRBS) examining tobacco and drug use patterns among US teens. Sample size include all regular public, Catholic, and other private school students in grades 9-12, in the 50 states and District of Columbia in this sampling frame for the 2015 NYRBS. Puerto Rico, trust territories, and Virgin Islands were excluded. Schools were selected systematically with probability proportional to enrollment in

grades 9-12 randomly. 125 schools participated with a sample of 18,165 students, with a response rate of 15,624 (86%). The 2015 NYRBS instrument covers 6 categories of health-risk behaviors, the prevalence of obesity, and other health-related topics. The NYRBS was approved by an institutional review board at the Centers for Disease Control and Prevention.

The study stated that SAS 9.4 was used to perform data analysis with 95% confidence. Results show that students who currently are smoking, vaping, or both were significantly more likely to use alcohol, currently use alcohol, have tried marijuana, currently use marijuana, have used drugs, and to have ever misused prescription drugs (Curran, 2018). The goal of this study for the researchers was to examine total inhaled tobacco use rate before and after the introduction of e-cigarettes and to understand the relationship between use of tobacco products and use of other drugs within adolescents. Despite a decrease in conventional inhaled tobacco use, the rate of use, including conventional and e-cigarette use remains unchanged since 2003 (Curran, 2018).

In addition, adolescents who were current users of tobacco products and e-cigarettes, were at higher risk of using other drugs and alcohol in comparison with nonusers (Curran, 2018). Despite this, e-cigarette use is linked to the lowest risk, exclusive conventional cigarette use was associated with intermediate risk, and use of both had the highest risk of drug and alcohol use. This study has several limitations. The NYRBS data only represented students who were enrolled in school, excluding home-schooled teens, or students absent day of or not enrolled in school on the study dates. In addition, because the data only came from the US, the results may not be generalizable to adolescents internationally. The NYRBS is a cross-sectional study and causal relationships cannot be established, and its questions do not differentiate what type of solutions students are using in their vaping devices, including if they are smoking nicotine or not.

### **Physiological Impact**

Researchers Husari, Shihadeh, Talhi, Hashem, Sabban, Zaatari, and El Sabban (2016) investigate the effects of e-cigarette vapor and cigarette smoke (CS) in an animal model and in human alveolar cell cultures in their article *Acute Exposure to Electronic and Combustible Cigarette Aerosols: Effects in an Animal Model and in Human Alveolar Cells, Nicotine & Tobacco Research*. In a study approved by the American University of Beirut Institutional Animal Care and Use Committee, four-month male mice were subjected to a 12-hour dark/light cycle. The mice were kept in chambers where temperatures remained at constant 22°C–24°C and had access to water and rodent chow when not in the exposure apparatus. In the study, mice were divided into Control, ECIG, and CS groups. The mice were exposed for six hours per day to either lab air, ECIG, or CS, for 3 days. The particulate matter exposure for the ECIG was set at a higher level compared to the CS. Lung injury was determined by: (1) measurement of wet-to-dry ratio; (2) albumin concentration in the bronchoalveolar lavage fluid; (3) transcriptional expression of inflammatory mediators IL-1 $\beta$ , IL-6, TNF- $\alpha$ ; (4) oxidative stress; (5) assessment of cell death; and (6) lung histopathology (Husari, 2016). In addition, human alveolar cell cultures were treated with various concentrations of ECIG and CS aerosol extracts and its effects were evaluated. The exposure apparatus consisted of a smoke generator, mixing/conditioning chamber and “nose-only” rodent exposure chambers. Mice were placed in their respective chambers and then were exposed for 3 consecutive days, twice daily for 3 hours each session from 9 am to pm. Results from the study showed that albumin leak was highly increased in CS compared with Control (Husari, 2016). CS exposure showed a significant increase of inflammatory markers when compared to control (Husari, 2016). Results then show that exposure to the tested ECIG aerosol has an “acute in vivo” harmful effect on lung tissue when compared to Control with a significant increase in the inflammatory mediator and IL-6

expression (Husari, 2016). However in a histologic examination, there was no evidence of increased apoptotic activity and had normal lung parenchyma in the ECIG group. One limitation of this study is that it only investigates the acute effects of exposure only because further research needs to be done to investigate chronic exposure.

In the final article reviewed, researchers Spindle, Talih, Hiler, Karaoglanian, Halquist, Breland and Eissenberg investigate the acute effects of ECIG liquid solvents, propylene glycol (PG) and vegetable glycerin (VG) in their article *Effects of Electronic Cigarette Liquid Solvents Propylene Glycol and Vegetable Glycerin on User Nicotine Delivery, Heart rate, Subjective Effects, and Puff Topography*. This study was approved by Virginia Commonwealth University's institutional review board. Participants were recruited via the internet, campus flyers and through local vape shops, or word of mouth. These participants were over 110 pounds, aged 18–55, used <5 tobacco cigarettes daily, used  $\geq 1$  ml of ECIG liquid daily, used  $\geq 6$  mg/ml nicotine concentration, and had used their ECIG  $\geq 3$  months (Spindle 2018). Exclusion criteria includes history of chronic disease or psychiatric condition, currently pregnant, regular use of a prescription medication, marijuana >10 and alcohol use >25 in the past 30 days (self report). In addition, participants were illegible if their screening results show: resting HR exceeding 110 beats per minute (bpm), systolic blood pressure (BP) greater than 140 mm Hg or diastolic BP greater than 100 mm Hg. Forty–one participants were selected and were provided informed consent for

the study however; only 30 of them completed the study or were ineligible during screening. In each session, participants were given an “eGo” battery with a dual-coil “caromizer.” These “cartomizers” were filled with 1 ml of ECIG liquid (Virginia Pure) containing 18 mg/ml of nicotine.

Participants completed four sessions that were around 3.5 hours each and were separated by more than 48 hours per session at VCU’s Clinical Behavioral Pharmacology Laboratory (CBPL). Each participant was asked to abstain from smoking at least 12 hours before each session. Abstinence was verified by confirming baseline plasma nicotine concentration. Following a one-hour observation period, an intravenous catheter was inserted into a forearm vein in order to monitor HR and blood samples were taken at different intervals. Results show that over a significant effect of time, there appears to be no significant effect for HR. HR increased significantly from 63.71 bpm at baseline to 70.98 bpm after bout 1 and 70.92 bpm immediately after bout 2 (Spindle 2018). Participants reported that the ECIG containing only PG was less “Pleasant” and less “Satisfying” than the 2 PG:98 VG and 20 PG:80 VG liquids. In conclusion, the results showed that ECIG liquid containing PG as the only solvent delivered more nicotine, reduced mean puff duration and volume, and was less satisfying overall to the participants (Spindle 2018). In addition, after ECIG use, increases in HR were observed. Several limitations were present in this study. Participants were not allowed to use their preferred ECIG and liquid. Secondly, the controlled puffing parameters may have altered the study outcomes because the users may increase their mean puff number, duration, and volume during use. Internal validity was maintained after direction in order to make the results more

interpretable. Lastly, puff duration and puff volume were not controlled, as the participants took shorter and smaller puffs in the PG-based conditions.

## **Conclusion**

Through the work of several researchers and scientists, the studies reviewed revealed possible physiological and habitual effects of smoking various vapors through e-cigarettes. These potential effects may be especially harmful in children and adolescents. Despite originally being used as a device to help smokers quit smoking combustible cigarettes, teenagers and adolescents are evidently beginning to abuse its intended use. As revealed through this literature review, it appears there is presence of toxic metals that cause cardiovascular disease and lung cancer (Olmedo, 2018). With this in mind, the author recommends that all parents be educated regarding the use of e-cigarette and should play a part in preventing future abuse of e-cigarettes in order to secure a healthier future for their children.

### **Conceptual Framework**

Psychologist Erik Erikson, who took Freud's psychosexual theory, and created his own theory on psychological development of human growth. Erikson theorized that everyone goes through the same eight stages of growth and psychosocial development. As an individual develops, he or she must confront two conflicting ideas or else be lead to feeling inadequate. These eight stages of psychosocial development include trust vs. mistrust, autonomy vs. shame and doubt, initiative vs. guilt, industry vs. inferiority, identity vs. role confusion, intimacy vs. isolation, generativity vs. stagnation, and integrity vs. despair.

According to Erikson, adolescents must face the paradox of "identity vs. role confusion." Majority of teenagers in middle school and high school go through similar situations where they try to "discover themselves." Those who are able to overcome this stage are able to find their own "identity" when transitioning into adulthood. Teenagers and other adolescents who are unable to overcome this obstacle become "confused" and may develop a weak sense of their "identity."

Most adolescents and young adults struggle to find their "identity" within themselves so they rely on their peers to help them find it. Because of this, many are influenced to make "good" or "bad" decisions, depending on their peer group (Cherry, 2018). Examples of this include study groups, charity drives, and participating in extracurricular activities. On the other end of the spectrum, some peer groups engage in abusing drugs, alcohol, or other illegal activities. Since peer pressure has a great effect on the decisions one can make, it is important that parents and people of authority are responsible for what teenagers are exposed to.

A relatively new high risk adolescent behavior is the use of E-cigarettes, also called vaping. Development theorists have described how adolescents do not view high risk behaviors

as something to avoid. Many teens participate in high risk behaviors as part of their growing identity. Vaping appears to be the new “identity” many adolescents are beginning to adopt within recent years. However, based on the review of the literature, this author suspects that this new vaping “identity” will lead to a road of addiction, substance abuse, and irreversible physiological damage.

### **Research Proposal**

The purpose of this study is to examine how adolescents describe their experiences and perceptions with electronic cigarettes in relation to health consequences. The author distributed a survey for participants to fill out regarding present e-cigarette use. Author secured permission from Dominican University IRB before distributing survey.

### **Sample**

This pilot study’s sample size will consist of participants gathered from one on-campus club. With consent of the participants and approval of Dominican University’s IRB, the students were given a survey through Google Forms to be completed anonymously. Twenty responses were gathered from the population.

### **Methods**

Author created a questionnaire regarding perceptions and beliefs about smoking electronic cigarettes. After securing IRB approval, author contacted a Dominican University on-campus club and its president for permission to distribute a survey to its members. This club was selected for this study because the club is composed of a diverse group of individuals who stem from many different backgrounds or communities and majors such as business, communications,

psychology and health sciences. The survey was open for around 2 weeks, then it was closed for data analysis. Author met with faculty advisor to analyze and interpret data.

### **Instrument**

Students will be given a 10 item Likert-scale questionnaire to fill out in about 10 minutes. This survey will obtain demographics such as sex, current grade in school, and age. This instrument will assess for their perceptions about vaping and their knowledge of health consequence.

### **Validity and Reliability**

Instrument was author developed. It has face validity based on my research questions and critical review of pertinent literature but that its validity and reliability has not yet been tested.

### **Confidentiality**

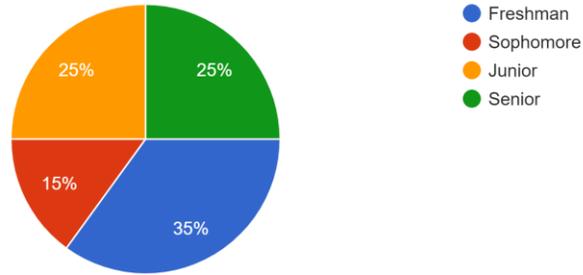
No identifying information will be asked of participants and no study data will be linked to individual participants. Data will be stored in a secured (locked) location under the continuous control of the researcher. Only the researcher and the faculty adviser will have access to the raw data, which will be shredded or deleted and discarded within 6 months of study completion

Raw data will be stored in a locked location on campus after being transcribed into a secured database within a statistical software program. The software will be kept on a password protected computer.

### **Findings**

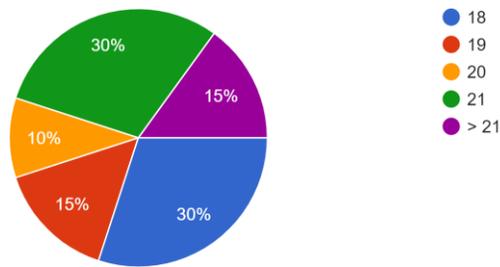
### Grade Level

20 responses



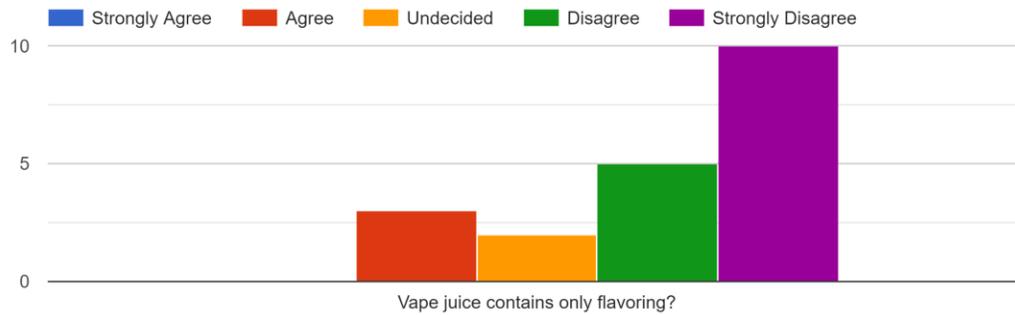
### Age

20 responses

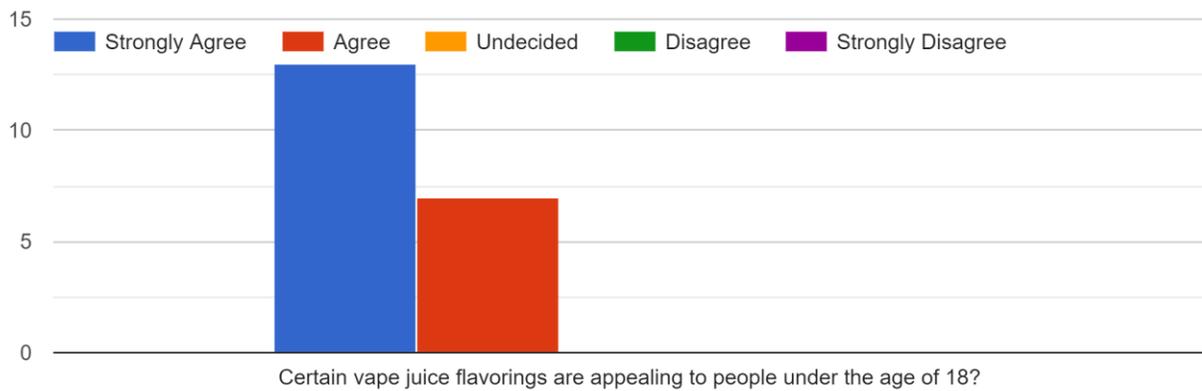


From the data collected, less than half of the sample population are at least 21 years of age. In the state of California, the legal age to purchase tobacco products is 21 (CDPH 2016).

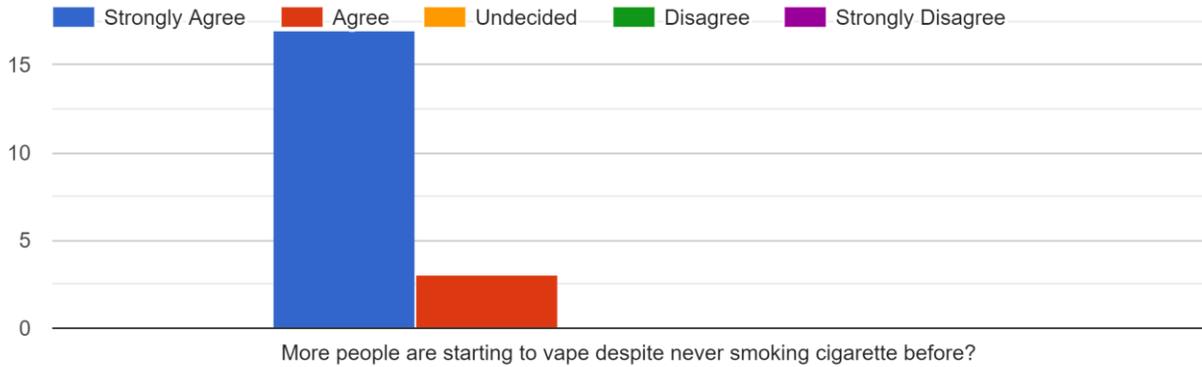
Do you believe that:



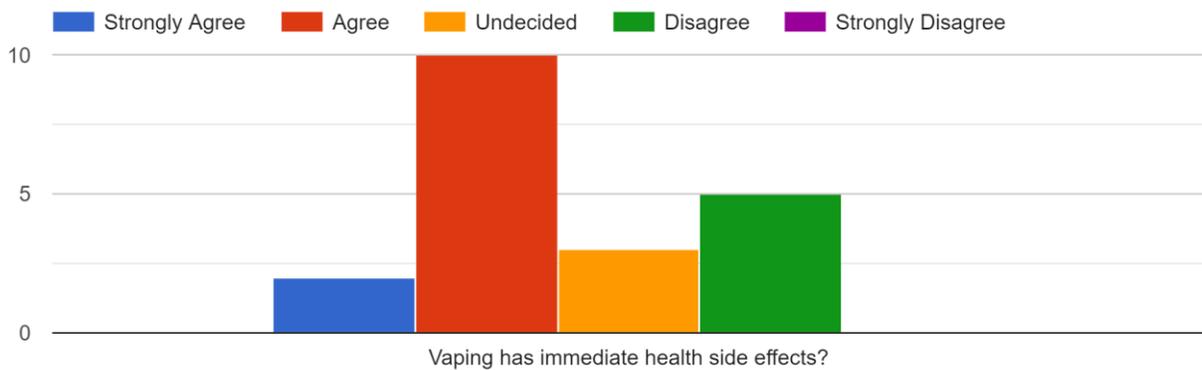
When the participants were asked if they believe that vape juice contains only flavoring, 75% of the participants either disagreed or strongly disagreed that vape juice contains only flavoring.



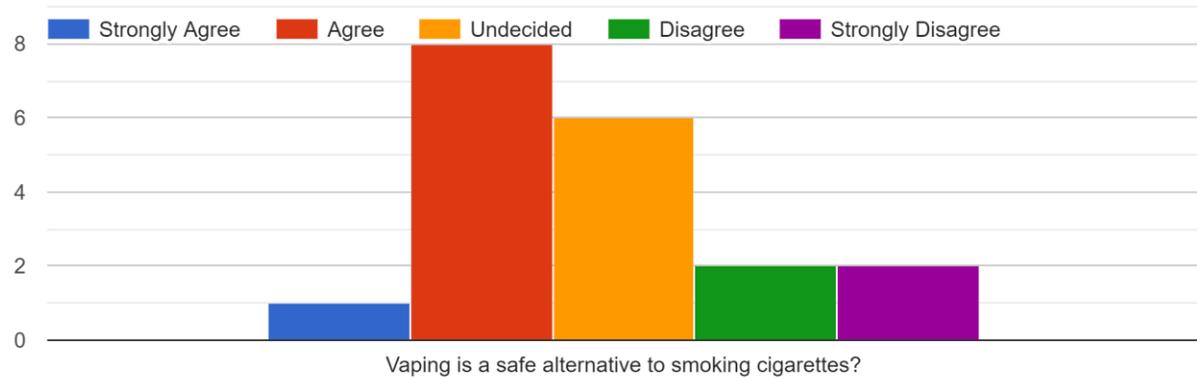
When the participants were asked if they believe that vape juice flavorings are appealing to people under the age of 18, all of the participants either agreed or strongly agreed with that statement.



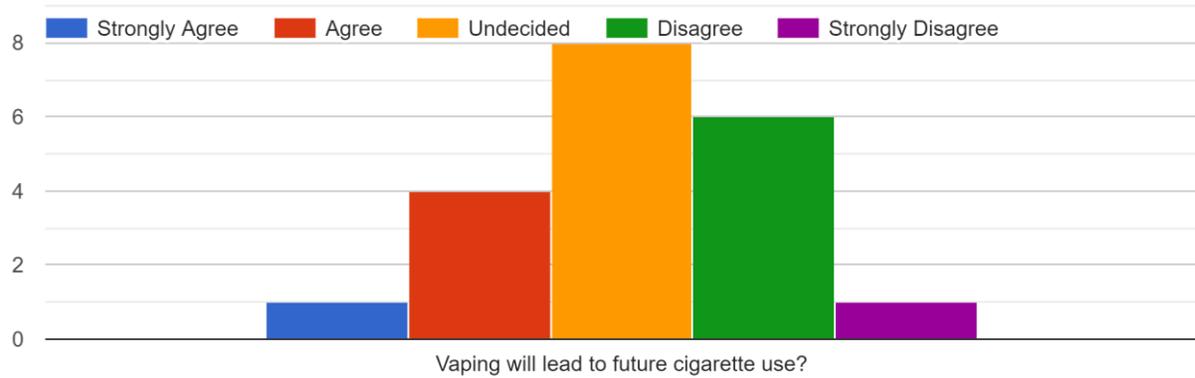
When the participants were asked if they believe that more people are starting to vape despite never smoking cigarettes before, all of the participants either agreed or strongly agreed with that statement.



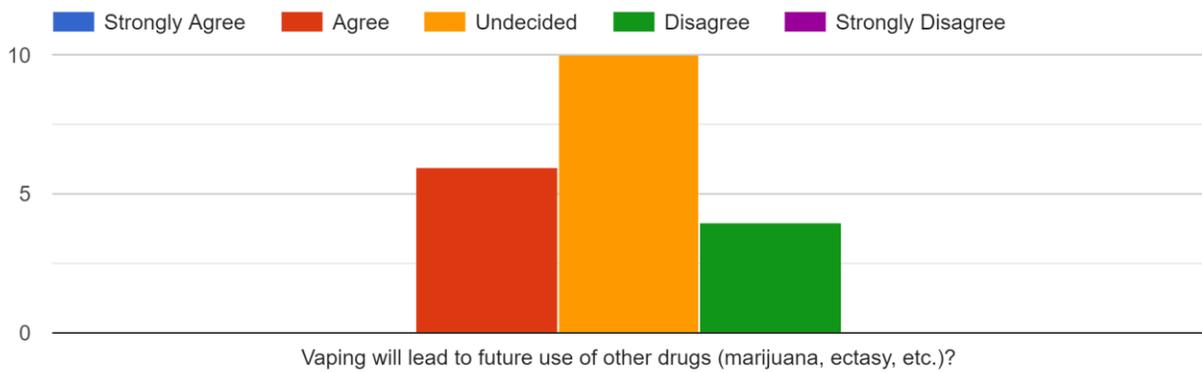
When the participants were asked if they believe that vaping has immediate health side effects, 60% of the participants either agreed or strongly agreed with that statement.



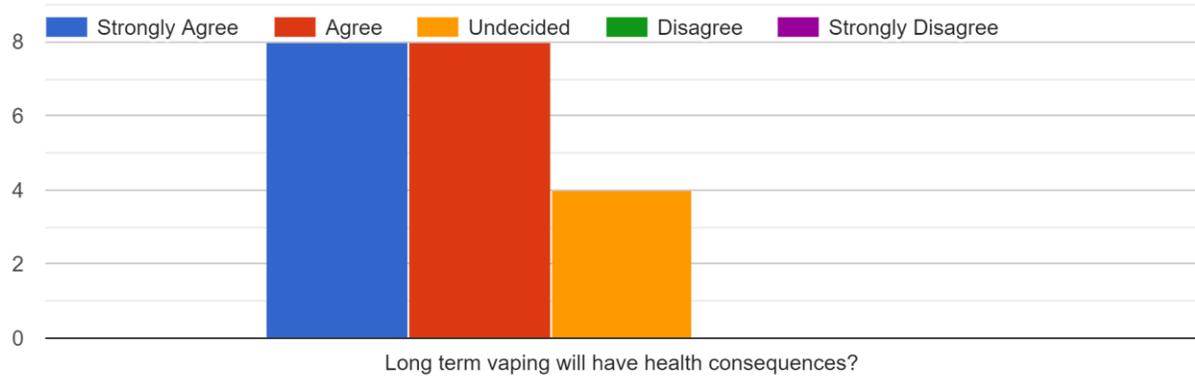
When the participants were asked if they believe that vaping is a safe alternative to smoking cigarettes, 45% of the participants agreed or disagreed with that statement, while 30% of the participants were undecided.



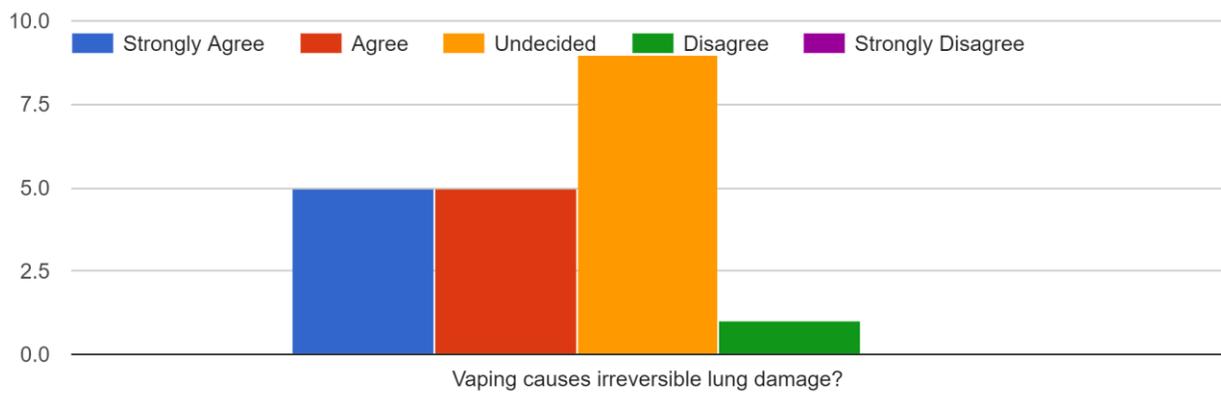
When the participants were asked if they believe that vaping will lead to future cigarette use, 40% of the participants were undecided, 35% either disagreed or strongly disagreed, and 25% either agreed or strongly agreed with that statement.



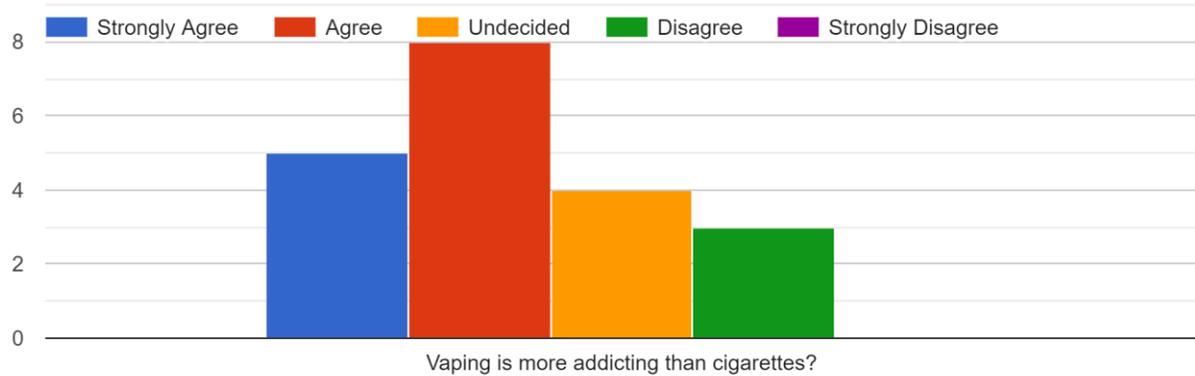
When the participants were asked if they believe that vaping will lead to future use of other drugs, 50% of the participants were undecided with that statement.



When the participants were asked if they believe that long term vaping will have health consequences, 80% of the participants either agreed or strongly agreed with that statement.



When the participants were asked if they believe that vaping causes irreversible lung damage, 50% of the participants either agreed or strongly agreed with that statement.



When the participants were asked if they believed that vaping is more addicting than cigarettes, 65% of the participants either agreed or strongly agreed with that statement.

### Discussion

From the data gathered from the participants, it appeared that this sample population shared certain beliefs and perceptions regarding electronic cigarettes. Most of the participants appear to be in agreement that vaping is appealing to minors, and that electronic cigarettes in general are enticing to non-smokers. In addition, most of the participants agree that there is a presence of long term health consequences. This group of college students disagree with the statement that vape juice contains only flavorings, it appears they know that vape juice contains more. However, the sample population appears to be undecided whether or not vaping causes

irreversible lung damage, vaping causes future cigarette use, or that vaping will lead to future use of other drugs.

It is evident that more people require education and correction about their misconceptions regarding vaping. Some ways these misconceptions can be fought are through informational websites, brochures, and social media movement. Schools can also have their school nurses give a presentation to the student body about the medical and health consequences of vaping. Lastly, parents should be educated about the dangers of vaping because the author's goal is to reduce the percentage of first-time vape users within adolescents.

### **Conclusion**

“Vaping” appears to be on its way to be the “cool thing to do” among adolescents ages 13 to 21. To many, vaping appears harmless when compared to combustible cigarettes because of the lack of tar and other carcinogens. However, the youth seems to be clearly unaware what composes their e-liquid beyond their “flavorings.” As shown through several studies, certain substances such as toxic metals have been shown to be present in different e-cigarettes. Because vaping is a relatively new trend in recent years, more research must be conducted in order to find the long-term physiological effects of vaping. In addition, both parents and other caretakers must be responsible in educating their children about the dangers of smoking e-cigarettes. The research shows that because of these “flavorings,” vape juice is more appealing to the youth because of its “taste” and enticing packaging. If caretakers are unable to educate these adolescents the dangers of habitual smoking of e-cigarettes, then the adolescents will fall into a cycle of future addiction, substance use, and combustible cigarette use.

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