Holistic Analysis of Effects and Habits of Nicotine E-cigarette Use Amongst US Teens

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Abstract

The purpose of this paper was to examine the effects of e-cigarettes and factors that affect the usage of e-cigarettes. Specifically, information was collected regarding health effects, mental health, age, gender, social media, environmental influences, and smoking abstinence associated with e-cigarettes from several recent studies from online databases. The products in e-cigarettes were shown to have negative health effects, especially on the respiratory system, the cardiovascular system, and the central nervous system. Gender and age affect both e-cigarette usage and its effects on the body, including behavioral issues and mental health. Outside influences such as peers, social media, and regulations can also play a role in who and how often a person is consuming e-cigarettes.

Introduction

Tobacco and nicotine products have been a staple in recreational drug usage in the United States for centuries. There are many different types of tobacco products, such as cigars, cigarettes, e-cigarettes, and hookahs, with cigarettes being the most common. There are also many smokeless tobacco products like chewing tobacco and snuff. Tobacco can cause many health risks. Smoking tobacco is the leading cause of premature death in the US and harms almost every organ in the body, causing 480,000 deaths annually. Tobacco products, including smokeless ones, contain chemicals that are carcinogenic. For example, ninety percent of all lung cancer deaths are due to smoking, and many mouth and esophagus cancers can be caused by smokeless tobacco products. Smoking can also cause other respiratory diseases such as chronic bronchitis, emphysema, and chronic obstructive pulmonary disease (COPD). Besides those, smoking tobacco has also been linked with many other diseases. Smoking tobacco increases the risk for cardiovascular diseases, due to its potential to damage a person's blood vessels and increase their blood pressure, which in turn can cause clots that lead to strokes. Additionally, smoking during pregnancy has been shown to cause low birth weight, preterm birth, restricted head growth, placental problems, and an increased risk of stillbirth and miscarriage (Health Effects of Cigarette Smoking).

More recently, there has been an explosive increase in the usage of vape and e-cigarette products, especially among young adults and teens. Vapes have become increasingly popular among teens due to their accessibility and appealing flavors. As of 2023, 1 in 22 middle school students and 1 in 10 high school students reported using e-cigarettes in the last thirty days (Youth and Tobacco Use). Some people believe that e-cigarettes are less harmful than other tobacco products, but vapes still have toxic chemicals, such as acetaldehyde and formaldehyde, and can lead to health consequences (The Impact of E-Cigarettes on the Lung). For teens, vaping can lead to nicotine addiction and affect their abilities to regulate their mood, focus, and impulse control. Another misconception about e-cigarettes is that they can help people quit smoking. Vapes still contain nicotine, a highly addictive substance which has been shown to lead to addiction to other drugs, also known as a gateway drug. Furthermore, studies have shown that people who smoke vapes are more likely to use other tobacco products (Vaping Devices (Electronic Cigarettes) DrugFacts).

Although e-cigarettes and vapes have been in the market for several years, little is known about the long term effects of chronic nicotine usage, particularly in younger people. This paper will discuss the physical and mental health effects of e-cigarettes, the impact of age, gender, regulations, social media, and environmental influence on their use, and the association of e-cigarettes with smoking cessation. This paper will provide an updated review about tobacco products and their association to chronic disorders, with a focus on e-cigarette and vape usage for teenagers and adults.

Health Effects

Given how vaping is a recent phenomenon that has started to gain prevalence, there are no longitudinal studies yet but there are several studies that can be used to help to build a foundation for the potential health effects of vaping. In e-cigarettes, the nicotine liquids comprise of nicotine, propylene glycol (PG), vegetable glycerin (VG), water, and sometimes flavoring. However, the contents can vary depending on the product. While the liquid is purified, there are still traces of nicotine-related alkaloids and tobacco-specific nitrosamines also known as TSA's, which are carcinogens. The concentration of nicotine varies depending on the product and has been increasing in recent years. While the full extent of the effects of PG and VG are still unknown, trials have shown that PG and VG statistically increase the likelihood of development of lung adenocarcinoma(Cao, Dazhe J. et al.). Moreover, the lungs have many defenses such as physical barriers, reflexes, the cough response, and more which help protect the lung. However, exposure to toxic substances can weaken their defenses and reduce their efficiency. For example, substances in cigarettes that are inhaled can penetrate the lung and be deposited (Pulmonary Diseases). While there are not yet longitudinal studies on the exact effects of e-cigarette usage on lungs, given the information discussed previously about lung adenocarcinoma and lung defense mechanisms, it is likely that e-cigarettes could be considered detrimental to lung function.

Beyond impacts to the lungs, data suggests that there are impacts to many other parts of the body as well. It was reported that in the short term, nicotine increases heart rate and diastolic blood pressure (Cao, Dazhe J. et al.). Nicotine is absorbed in the bloodstream and transferred to the adrenal glands in the kidney which are then stimulated. The glands then release adrenaline which leads to the increase of blood pressure, respiration and heart rate. Nicotine also activates reward pathways in the brain that lead to the feeling of pleasure (How Does Tobacco Deliver Its Effects?). The dopaminergic system has nicotine receptors that nicotine binds to, activating the system. This releases dopamine and causes feelings of pleasure. According to researchers, this is one of the reasons why nicotine reinforces behavioral change and leads to dependence of nicotine (Tiwari, Raj K. et al.). Cardiac function can also be affected by e-cigarettes. The formaldehyde from the e-cigarettes and its combustion products can cause a decrease in the left ventricle end-systolic pressure and cardiac output. Similarly, aldehyde can cause myocardial mitochondrial damage. Additionally, the nicotine from the e-cigarettes can lead to an acute cardiac arrhythmia, where signals sent to the heart to beat do not work properly (Espinoza-Derout, Jorge et al.). It was reported that there was an increase in worsening asthma, coughing and wheezing in adolescents who smoke e-cigarettes (Cao, Dazhe J. et al.). Studies have also reported that the usage of vapes and e-cigarettes during times of brain growth during adolescence can lead to behavioral changes and hyperactivity. A study found that smokers had an increased risk of physical fighting and attempted suicide compared

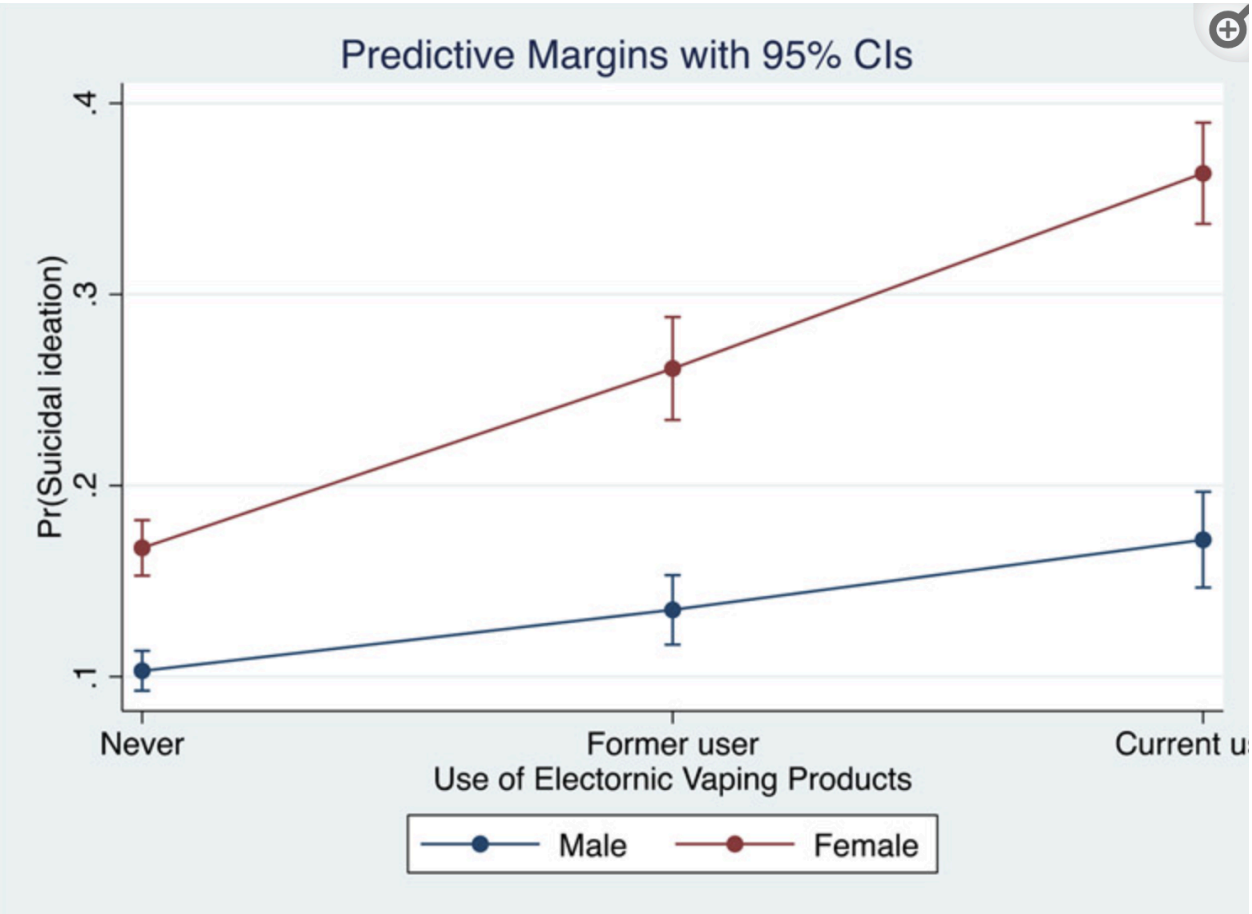
to non-smokers (Jones and Salzman). While there is still still very little known about the long term effects of e-cigarettes, these studies point to the potential impacts across many components of physical health.

Mental Health

Beyond the physical health impacts, the mental health impacts of nicotine were examined. Nicotine from vaping has been commonly used and abused because of its effects on a person's mood, specifically because nicotine activates reward pathways, giving a feeling of pleasure. One study conducted to understand the association between electronic vaping devices and mental health in adolescents found that 47% of adolescents who were current e-cigarette users reported having symptoms of depression compared to the 38.3% and 27.3% of former and never e-cigarette users. Additionally, the percentage of current e-cigarette users who had suicidal thoughts was 26.1%, while it was 19.9% for former users and 13.6% for never users. As for adolescents, the percentage of those who made a suicide plan and had a suicide attempt was consistently higher for current users compare to those of former e-cigarette users and never users (Baiden, Philip et al.). For adolescents, those who had or were currently using e-cigarettes showed an increase in symptoms of depression and suicidal thoughts, suggesting that e-cigarettes can cause a shift in mood.

There are also differences in mental health between genders. Statistics from a study showed that women in general were almost twice as likely as men to have depressive episodes. Additionally, those who smoked e-cigarettes were twice as likely to have depressive episodes than those who did not smoke. Former e-cigarette smokers were also still more likely to have depressive episodes, for both genders, compared to non-smokers (Sung, Baksun). Another study found that among current e-cigarette users, females adolescents were more likely to have symptoms of depression, suicidal thoughts, and suicide plans compared to males (Javed, Sana et al.). Overall, depression was shown to increase the likelihood of triggering e-cigarette usage. Concurrently, e-cigarette usage was found to cause elevated depressive symptoms (Lechner, William V, et al.).

Predictive Likelihood of the Relationship Between Suicidal Thoughts and Use of Vaping Products in Men and Women (Figure 1)



(Baiden, Philip et al.)

Age

Age was examined to understand the pervasiveness and change of e-cigarette usage across different populations, as well as the potential impacts on different age groups. E-cigarettes have been becoming increasingly popular among teens and young adults. In 2014, they were the commonly used tobacco products by US adolescents, with a dramatic increase in vaping in high schools. The PATH survey was conducted with two cohorts, one before the rise of e-cigarettes (Pre-JUUL) and one during the JUUL era. They found that in both cohorts of new users, the age group with the highest usage of e-cigarettes was between 14 to 17 years old. The age group 18-21 also showed an increase in usage from the Pre-JUUL to JUUL era. In terms of daily users, there was a significant increase in the amount of e-cigarette usage, especially for the 14-17 and 18-21 age groups (Pierce, John P et al.). Overall, in recent years, adolescents and young adults are the leading age groups in e-cigarette usage. According to the CDC, there was a 78% increase in the usage of e-cigarettes by high school students in 2018. Furthermore, in 2021, 4.5% of adults were current e-cigarette users with the highest being within the age range of 18-24. As of 2020, 3.6 million US youth smoke e-cigarettes with 80% using flavored e-cigs. A study which compared the current use and frequent use of e-cigarettes for high school students in 2015, 2017, and 2019 showed that there was an increase in usage. This increase was not only with former cigarette smokers but also people who had never smoked

cigarettes. They reported a 464% increase in the frequency of e-cigarette smoking out of previous never cigarette smokers (Mirbolouk, Mohammadhassan et al.). The rise in popularity in e-cigarette has led to an increase in usage, especially among youths, and a leap in new e-cigarette smokers.

In order to understand the impact of e-cigarettes on various youth populations, a study was conducted on rodents who have similar patterns of brain development with those of humans to see the effects on nicotine. In the rodent models, nicotine amplified neural activity in regions involved in reward systems, more so for young mice than adult mice. Young mice were shown to have a higher sensitivity for the reward effects of low levels of nicotine. This brings up the likelihood that human adolescents might be vulnerable to becoming dependent on e-cigarettes as there is more sensitivity to nicotine reward pathways compared to adults. This vulnerability can lead to an increased risk of drug-seeking behaviors, attention deficits, and mood disorders. Models have also shown that adolescents' brains are still maturing and can be subject to long-term modification because of nicotine (Health Effects of E-Cigarette Use Among U.S. Youth and Young Adults). While more research is needed, the results from the rodent study suggest that e-cigarettes could have potentially damaging effects on adolescents.

Gender

Another key factor that was examined was the differences that gender might have on the severity of e-cigarette usage and its effects. While previously, smoking was higher among men compared to women, recently e-cigarette usage among women has been increasing, causing the difference between the two genders to decrease. E-cigarette products have promoted things such as weight loss as well as having packaging that is appealing to women. Furthermore, the effects of nicotine in women and men are different. Nicotine is metabolized by women at a faster rate than men due to women's higher amounts of estrogen, leading to a harder time quitting smoking, less rewarding effects from nicotine, and worse side effects (Kong, Grace et al.).

One study found that among people who currently smoked e-cigarettes, the probability of them quitting was higher for men than women. Similarly, the study found that there were more women who switched to using e-cigarettes when trying to quit compared to men. However, according to the study, in terms of 6-month cessation, there was no significant difference between gender and e-cigarette usage (Abrams, Leah R et al.).

E-cigarette regulations

Given the increasing frequency of vaping usage, especially among youth populations and the aforementioned impacts on physical and mental health, the regulatory framework of e-cigarettes was examined to understand its impacts on the consumption of e-cigarettes. As e-cigarettes are the most commonly used tobacco product among adolescents, states have started to put regulations and restrictions on e-cigarettes. One study found that states with restrictions on non-tobacco-flavored e-cigarettes had a decrease in sales. Although the decrease in non-tobacco-flavored e-cigarettes prompted an increase in tobacco-flavored e-cigarettes, the total net amount of e-cigarettes bought had decreased (Ali, Fatma Romeh M. et al.). Furthermore, a study found that restrictions of certain flavors led to a change in the device they were using, what flavors they used, the places they bought from in order to obtain the flavor, or if they made their own flavors (Bold, Krysten W. et al.).

Previous regulations on tobacco products showed that it was hard to limit the youth purchase of tobacco. However, regulation entitled Tobacco 21, which raised the legal purchase age in California to 21 years of age, resulted in a decrease of 8% in smoking for high school students. Young adult users of e-cigarettes were less likely to agree to the regulation, signifying that it was due to their lack of knowledge about the damaging effects of e-cigarettes. Since the passing of the Tobacco 21 regulation in California, there has been a dramatic decrease in the amount of tobacco products used among California youth. The effectiveness of the restriction showed that a similar process can be taken in order to reduce the vaping epidemic (Kim, Samuel C J. et al.).

Of the 50 states, the age limit for purchasing vapes are 19 for Alaska and 18 for Arizona, Kansas, Michigan, Missouri, Montana, North Carolina, South Carolina, West Virginia, and Wisconsin. The other states have an age limit of 21(Lombardi, Kevin). The Preventing Online Sales of E-Cigarettes to Children Act was a bill passed by Congress on July 2nd, 2020 which subjects the sale and delivery of nicotine delivery systems including tax, licensing and labeling requirements; prohibits the sale and delivery to those underage; requires the US postal system to implement regulations when delivering; and requires the National Institute of Health to conduct a study on the health impacts of e-cigarettes on youth (S.1253 - Preventing Online Sales of E-Cigarettes to Children Act). Given the success of the California Tobacco 21 regulation, similar policies could be implemented to reduce e-cigarette usage.

Influence of Social Media/Advertisements

Social media is undoubtedly a huge influencer on all aspects of life and thus the impact that social media platforms have on the promotion of e-cigarettes was examined. Social media platforms have two main types of exposure to promote e-cigarette. One is content from a pro-substance/e-cigarette person and the second is advertisements. These types of exposures can influence people, specifically young adults. The most common types of advertisement were vape stores, convenience stores, gas stations, on TV, Facebook, Instagram, Youtube, and other websites (Groom, Allison L. et al.). E-cigarettes are often advertised to be a safer option compared to cigarettes and the “cool” or more socially favorable choice. In a study conducted on college students from two year and four year colleges in Oahu, they found that higher social media exposure was associated with higher positive outcome expectancies or positive smoking experiences, also related with current e-cigarette usage (Pokhrel, Pallav et al.). Other research has shown that young adults exposed to messages that display e-cigarettes as socially favorable have an increased susceptibility to smoking e-cigarettes.

Additionally, a study conducted to examine tobacco advertisement liking with tobacco use found that for liking e-cigarette advertisements, there was a greater chance of e-cigarette use. Another report found that a greater amount of exposure to e-cigarette ads led to an increased positive outcome expectancy. The participants reported seeing e-cigarette related posts and advertisements sometimes or often on Facebook and Instagram(Pokhrel, Pallav et al.). A study conducted in 2014-2016 reported that 78% of middle and high school students had been exposed to e-cigarette advertisements (Mirbolouk, Mohammadhassan, et al.).

From Google trends, since 2004, there has been a gradual increase in the amount of interest in “vapes” (Figure 2). For the term “Electronic Cigarette” there was also an increase in interest overtime with a peak in September of 2019 (Figure 3).

Popularity of Google Searches for the Word “Vapes” from 2004-2023

Popularity of Google Searches for the Word “Electronic Cigarette” from 2004-2023

Overall, increased social media exposure plays a role in elevated e-cigarette usage and experience.

Environmental Influence (Family, Peers, etc.)

Beyond social media, family and peers can heavily influence the usage of e-cigarettes, especially among certain younger populations. A qualitative and quantitative online study conducted on US teens ages 13-18 to see the influence of friends on vaping in teens found 54% of them reported trying their first e-cigarette while they were with friends. Furthermore, many of the respondents reported that after their first vaping experience, they bought more on their own through a friend, a friend’s older sibling, or a friend of a friend. The respondents wrote that they would vape with friends and while socializing with friends. Many also wrote that they would often vape less when in the presence of friends who did not vape (Groom, Allison L. et al.). At 16 years old, there was an increase in odds of using e-cigarettes by 1.39 in males and 2.01 in

females when increasing the number of friends who used e-cigarettes by one. At 20 years old, the likelihood of using e-cigarettes for every friend who used e-cigarettes was 2.24 for males and 1.74 for females(Etim, Ndifreke et al.).

Another study conducted found that having family members who smoked had an increased likelihood of e-cigarette usage. More specifically, the probability was the highest when a sibling smoked (Wang, Jian-Wei et al.). The same study also found that adolescents who had friends who smoked had a higher probability of using e-cigarettes. Furthermore, a study conducted on alternate high schoolers between 15-20 years of age found that female students that were living with an e-cigarette user had a higher probability of currently using e-cigarettes than those who lived with a non-user (Etim, Ndifreke et al.). Ultimately, social pressure as well as modeling from peers can influence adolescent's e-cigarette usage.

Quitting Smoking : How vapes help or don't help to quit smoking?

One of the often heard perceptions of e-cigarettes is that they aid in the cessation of traditional smoking. Thus, the data related to whether or not there are any positive benefits from e-cigarettes was explored. One study found that in 2014-2015, 17.4% of US smokers used e-cigarettes to quit smoking. In 2017-2018, of those who used e-cigarettes to quit smoking, 12.9% abstained for at least twelve months compared to the 11.3% who did not use e-cigarettes to quit (Chen Ruifeng et al.). Furthermore, another study found that of current smokers who used e-cigarettes, 81.3% used them to reduce smoking, 78.2% for enjoyment, and 74.5% because they believed vaping was less harmful than smoking to others (Gravely, Shannon et al.). It was found that abruptly switching to e-cigarette usage from other tobacco products such as cigarettes instead of gradually switching led to a longer duration of smoking abstinence. Additionally, using e-cigarettes more frequently throughout the day instead of just once or twice a day led to 19 more days of smoking abstinence and vaping constantly during the day led to 30 more days of smoking abstinence (Bold, Krysten et al.).

A study examining the association between e-cigarette flavors and quitting smoking found that restricting certain e-cigarette flavors changed the participants' usage behavior but did not help them quit smoking (Bold, Krysten W. et al.). On average, people reported using 2.7 different flavors when trying to quit, however the type of flavor and number of flavors a person used was not associated with their length of time they quit smoking (Bold, Krysten et al.). To help quit smoking, people often use nicotine patches, gums, and lozenges. Using e-cigarettes containing nicotine was found to be more effective in helping people quit smoking compared to the other nicotine treatments listed previously (Lindson, Nicola et al.). While there could be potential improvement of smoking cessation for prior tobacco smokers from the usage of e-cigarettes, more studies must be done to weigh the benefits and detriments of its usage.

Conclusion

With the recent rise of e-cigarettes in the past couple of decades, there is still little known about the extent of its effects. However, there has been research that shows that substances contained in e-cigarettes can increase a person's likelihood for lung related diseases. In terms of e-cigarette usage, a variety of factors such as gender, age, mental health, social media, previous cigarette usage and more can affect a person's e-cigarette usage. As the usage of e-cigarettes continues to rise, more thorough studies should be conducted about the magnitude of its effects. For example, a longitudinal study on people who consistently smoke e-cigarettes

compared to those who never smoke could be conducted to study the long term effects of e-cigarettes. Since e-cigarettes are popular among youths, it is important to examine the short and long term impacts of e-cigarette usage on their development.

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