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The Real Cost: Targeted Advertising and Health Outcomes with Nicotine Vaping

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Abstract

Vaping has become a highly popular form of using nicotine in the last decade and is thought to be a less harmful alternative to smoking combustible cigarettes. As popularity continues to increase, especially among teens and young adults, there is still very little information regarding the long-term health effects of vaping. This review will analyze vaping's fast rise to prominence, negative physiological effects, as well as targeted flavoring and advertising towards youth. Although data is limited, nicotine vaping has been associated with many acute health problems, including increased blood pressure, increased arterial stiffness, and excess free radical production, all of which increase an individual's risk of heart disease, stroke, and other adverse health outcomes. In the future, longitudinal studies of frequent users of nicotine vapes must be conducted. This is necessary in order to adequately assess how consistent use of e-cigarettes over many years can affect the user's health in comparison to combustible cigarettes.

"FDA Launches New Campaign: 'The Real Cost' Youth E-Cigarette Prevention Campaign." *U.S. Food and Drug Administration*, FDA, 1 May 2020, https://www.fda.gov/tobacco-products/youth-and-tobacco/fda-launches-new-campaign-real-cost-youth-e-cigarette-prevention-campaign.

Keywords: nicotine, vaping, e-cigarette, health, advertising

Introduction

Traditionally, nicotine has been inhaled through the use of combustible cigarettes that contain the same nicotine used in e-cigarettes. In the 1930s, cigarette smoking became initially recognized as a carcinogenic behavior, and in 1964, the US surgeon general's report on cigarettes indicated that smoking cigarettes was the leading cause of lung cancer.[1] As the negative consequences of smoking cigarettes became apparent, e-cigarettes were advertised as a healthy alternative to those looking to reduce smoking or quit altogether. Vaping is the process of using a battery powered cigarette (e-cigarette) in order to heat up nicotine to inhale as a vapor.[1] Despite a rapid rise in popularity, not much is known about the long-term implications of e-cigarette use as it is relatively new technology. Recent studies, though, have shown that pulmonary damage typically affecting cigarette smokers, such as a collapsed lung, also afflicts e-cigarette users in much the same way.[2] Although e-cigarettes were first introduced to the market 15 years ago, the founding of Juul in 2015 and their rapid rise to popularity in 2018 accounted for e-cigarette sales more than doubling at that time.[1] Juul's prominence has had a profound effect on the demographic of its users, as vaping by high school students has increased by 900% since 2016.[3] This review will discuss the history of vaping, physiological effects, and big tobacco companies' role in targeting products and advertisements towards teens and young adults.

Comparing Electronic & Combustible Cigarettes

E-cigarettes were initially introduced as a mechanism to help chronic smokers quit smoking or transfer to a less harmful form of using nicotine.[1] Compared to cigarettes, which contain about 7,000 chemicals and 70 known carcinogens in its smoke, an e-cigarette contains just a few key components: the battery, atomizer, coil, nicotine and flavoring chemicals.[3] The founders and supporters of e-cigarettes cite their simplicity as one of the main reasons they are less harmful than

combustible cigarettes. In a 2015 web study of Hungarian men who smoke cigarettes, 11.8% of participants smoking only e-cigarettes experienced adverse events (coughing fits, sore throat, heart palpitations, etc.) compared to 26.2% of users of both cigarettes and e-cigarettes.[4] Although smoking cigarettes and e-cigarettes together caused a higher rate of adverse events, only about one out of every eight men who smoked only e-cigarettes in the study experienced the same adverse effects. This data supports the idea that e-cigarettes are likely safer than combustible cigarettes but fails to address the potential harm caused specifically by e-cigarettes.

In a study of 114 frequent middle-aged cigarette smokers who began smoking in their teens, those who only smoked e-cigarettes in the trial consistently experienced better arterial function than those who only smoked cigarettes.[5] A flow-mediated dilation (FMD) test was utilized in the trial as it measures arterial blood flow and is a trusted predictor of heart disease. Those who used e-cigarettes for a month experienced up to a 3% increase in the dilation of their arteries in response to the test while cigarette smokers' arteries had little to no change or response to the test.[5] Effectively, the arteries of the e-cigarette users exhibited more functionality and responsiveness than those of the cigarette users. In the short-term, the cardiovascular health of those who switched to e-cigarettes from cigarettes significantly improved, suggesting a lowered risk for a heart attack. The reduced rate of harmful events and better cardiovascular function in smoking only e-cigarettes show they could be a tool for quitting cigarettes, but still come with an array of health consequences that many do not realize or ignore.

Negative Physiological Effects of E-Cigarettes

Despite being a less harmful alternative for adults than combustible cigarettes, e-cigarettes cause short-term health issues as well. Cigarettes are a known carcinogen and lead to a wide array of illnesses from chronic use, such as heart and lung disease. It is debated to what extent e-

cigarettes are similar to cigarettes in this way. In a study of 25 former tobacco smokers, vaping with nicotine caused impaired vasodilation (natural process of the widening of the blood vessels), increased arterial stiffness, and increased systolic and diastolic blood pressure immediately after use.[6] Along with this, a study of chronic e-cigarette users in 2019 showed that vaping led to a decrease in arterial oxygen levels five minutes after the participant's first puff.[7] Both of these studies suggest that in the short-term, blood pressure, arterial health, and oxygen levels are negatively impacted by just a single use of an e-cigarette. Restricted arterial blood flow and repeated oxidative stress are main causes of a blood clot, which, if present over time, can contribute to decreased heart function and possibly a heart attack or stroke.

In addition to acute cardiovascular issues, acute respiratory distress is also observed in those who use e-cigarettes. In a study of 17 healthy subjects, one group vaping e-cigarettes with nicotine was compared to a control group that vaped e-cigarettes without nicotine. Just 30 minutes after exposure, those who vaped nicotine-containing e-cigarettes experienced statistically significant restriction of their airway at every frequency of measurement (5, 11, 13, 17, and 19 Hz), while those who vaped without nicotine consistently had slightly less airway restriction over time.[8] Table 1 illustrates the specific cardiovascular and respiratory effects that e-cigarettes have shortly after use.

As well as causing short-term airway restriction, transmission of COVID-19 could increase as a result of sharing e-cigarette devices with those who are positive for the virus. COVID-19, which has affected over 630 million people globally at the time of publication, is a pneumonia-like respiratory disease that typically causes minor symptoms in healthy individuals but can lead to serious complications in those who are elderly or immunocompromised.[9] Great potential for transmission lies in the fact many healthy people who contract COVID-19 are asymptomatic and could be unknowingly spreading the virus to others. According to a study on tobacco smoking (cigarettes or e-cigarettes),

possible modes of transmission include exhaled smoke, coughing, sneezing, as well as a previous user's saliva.[10] For those who are high-risk for severe complications from COVID-19, sharing e-cigarettes with others could have dire consequences. In addition to this, the negative short-term cardiovascular and respiratory effects associated with e-cigarette use may worsen complications for those who contract the virus.

Along with potentially being a risk factor for cardiovascular and respiratory issues, highly reactive free radicals are produced from e-cigarette aerosol that could cause cancer and other issues.[11] When the body experiences oxidative stress, whether that be from an internal source or external source, there is an excess of free oxygen radicals in the body. Although the body has antioxidant defense mechanisms, an excess of free radicals damages cells due to their abundance and high reactivity from missing an electron in their outer shell.[12] As a result, free radicals readily fill their outer shell of electrons through binding to important cellular structures resulting in damaged DNA, enzymes, membranes, and overall impaired cellular function.[12]

In a study of various e-cigarette solvents and atomizers, free radical production from vaping 200 times in one day (around 25 sessions) was measured at 2×10^{15} rad/day, while the radicals produced from air pollution in one day are around 2×10^{14} rad/day.[11] This data indicates that e-cigarettes expose users to about 10 times more free radicals daily than those who are frequently exposed to air pollution, which has been linked to lung cancer and DNA damage. Over time, chronic e-cigarette inhalation could potentially cause an accumulation of free radicals, which have been correlated to accelerating the development of certain cancers, atherosclerosis, and other health issues.[13] Studies on atherosclerosis have indicated that a possible primary contributor to developing the disease is through free radicals reacting with excess lipids from the diet.[13] Although the free radicals react with excess lipids in atherosclerosis, the accumulation of free radicals from e-cigarettes could increase the

chance that destructive reactions occur due to a higher abundance of radicals. It is difficult to accurately say, though, how the human body would respond after prolonged e-cigarette use without longitudinal studies. However, in the short-term, increased free radical production in the body and decreased cardiovascular and respiratory function are direct consequences of e-cigarette use.

Targeted Teenage Products and Advertising, Abuse

With the creation of Juul has come a sharp rise in use of e-cigarettes among teenagers and young adults, mainly due to targeted advertising that pushes attractive non-traditional flavoring options like fruit and candy flavors. In a 2019 study of Los Angeles high school students, vaping with non-traditional flavors (fruit, candy, etc.) compared to traditional flavors (mint and menthol) correlated to greater odds of continuing vaping as well as a greater number of puffs per session.[14] The introduction of non-traditional flavors effectively lured adolescents to not only try vaping but continue using for longer and more often than those who only vape traditional flavors. In a study of cigarette smokers who were given e-cigarettes for a 6-week period but still allowed to smoke cigarettes, menthol flavoring decreased use of both e-cigarettes and cigarettes, while those who smoked chocolate flavoring responded with an increase in smoking throughout the study.[15] One potential cause of this is the menthol flavoring is likely less reinforcing to the user than flavors that taste like food or other pleasurable tastes. Along with this, menthol tends to inhibit nicotine metabolism, which may prompt those who smoke menthol e-cigarettes to smoke less.[15] In conclusion, the introduction of attractive flavoring to the e-cigarette market has caused increased usage of a product that was initially meant to wean cigarette users to a less harmful alternative rather than attract new young consumers. There is a clear affinity for e-cigarette users to gravitate towards more enjoyable flavors and as a result are used more frequently.

Along with targeting using flavors, tobacco companies like Juul have also targeted a young demographic based on where their advertisements are shown. The 2017 International Tobacco Control Youth Tobacco and Vaping Survey revealed that 81% of U.S. youth (aged 16-19) are familiar with and have been exposed to vaping advertisements.[16] Attractive flavors for teenagers, use of young and healthy models, sleek design, and the addition of vivid colors are all factors indicating that vaping advertisements are clearly directed towards enticing youth to engage in using e-cigarettes, such as Juul. With the combination of these factors, big tobacco companies have shifted the demographic of e-cigarette users from those trying to quit cigarettes to mostly teens and young adults who have never smoked before in order to make a greater profit, ignoring the negative impact their products and advertisements have on the youth.

As of March 2019, vaping has become two to three more times common in young adults and adolescents than any other age group as a result of targeted advertising and flavoring options.[17] The benefit of using e-cigarettes as a method for the cessation of smoking combustible cigarettes still exists but has become greatly overshadowed by teen abuse. The effects of chronic use of e-cigarettes, especially starting as a teenager or young adult, are not well documented due to the recency of the popularity of e-cigarettes, but data shortly after use consistently reveals negative instantaneous effects to cardiovascular and respiratory function. Although these are just short-term effects, they could cause health issues later in life as well as increasing the likelihood of cardiovascular events such as a heart attack and stroke. Due to the potential for negative health consequences in the future, attractive flavoring and advertisements are influencing many youth to engage in potentially risky behavior. Furthermore, the maturation process is a time of constant developmental transition in finding self-identity, establishing peer relationships, and understanding social independence that can cause youth to make emotionally influenced and rash decisions.[18] In conclusion, Juul's targeting of a young

demographic could lead to addiction and abuse from a young and susceptible population, which could potentially cause a wide array of health issues as those people get older.

Conclusion

E-cigarettes have become a widely popular means for those who smoke combustible cigarettes to switch to a less harmful alternative or eventually quit altogether. Better cardiovascular function, for example, has been observed in those who have switched from chronic cigarette use to e-cigarettes. E-cigarettes, though, do not come without their fair share of health issues as well. In the short-term, vaping e-cigarettes is known to cause adverse changes to respiration, blood pressure, and oxygen levels while possibly creating free radicals in the body that cause cancer, much like cigarettes. Abuse by teens and young adults has become an issue as well, as the intended audience was initially meant to be those looking for an option to quit using cigarettes. Companies, like Juul, have capitalized on e-cigarette popularity amongst youth by creating attractive flavors and advertisements for young consumers to abuse. While e-cigarettes have become popular in the last decade for these reasons, there is much left to learn concerning their long-term impact on physical health. Short-term trials have indicated the potential for e-cigarette use to cause cardiovascular events such as a heart attack and stroke. Long-term longitudinal studies must be conducted on the first wave of chronic vapers in order to compare them to lifelong smokers of traditional cigarettes, who have an increased risk for heart and lung disease, stroke, and various cancers.

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Table 1

Acute Cardiovascular and Respiratory Consequences of Nicotine Vaping

	Baseline	After exposure	Baseline	After exposure
Aortic PP (mm Hg)*	25.6 ± 1.1	29.3 ± 0.9	26 ± 1.1	25.9 ± 1.5
Aortic SBP (mm Hg)*	94.2 ± 1	103 ± 2.6	94.1 ± 1.4	93.1 ± 1.7
PWV (m/s)*	4.9 ± 0.1	5.3 ± 0.1	5.1 ± 0.1	5 ± 0.1
Plasma MPO antigen (ng/mL)**	13.6 [10–17.7]	18.9 [12.2–54.5]	11.3 [9.6–14.8]	11.3 [7.8–18.6]
Flow resistance (5 Hz)***	3.57 ± 0.73	3.85 ± 0.93	3.41 ± 0.75	3.26 ± 0.70
Flow resistance (19 Hz)***	3.23 ± 0.55	3.55 ± 0.74	3.09 ± 0.69	3.04 ± 0.64

* **Measures of Arterial Stiffness**, Aortic PP = Aortic pulse pressure (heart force with each contraction), Aortic SBP = Aortic systolic blood pressure (pressure in arteries with each heart contraction), PWV = Pulse wave velocity (the rate at which pressure waves move down vessels)

** **Measures of Oxidative Stress**, Plasma MPO antigen = Plasma myeloperoxidase antigen (indicator of future cardiovascular events / risk of heart disease)

***Measures of Respiratory Stress**, flow resistance measures the extent to which the airway is restricted during inhalation and exhalation at different frequencies; higher values represent a more restricted airway

Aortic PP, Aortic SBP, PWV, and **Plasma MPO antigen** data synthesized from source 7.

Flow resistance (5, 19 Hz) data synthesized from source 8.