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Why Teens are Particularly Vulnerable to the Harms of Vaping Addiction: A Literature Review

by

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Introduction

Vaping, or the use of e-cigarettes, is a growing public health concern in the United States. Vapes entered the United States market in 2007, originally marketed as a healthier alternative to cigarette smoking and a tool to help cigarette smokers quit. Unfortunately, research shows that vaping's potential value as a smoking cessation tool is significantly outweighed by its harms, especially upon teenagers who are particularly susceptible to deceptive marketing and social pressures, and therefore especially vulnerable to vaping addiction and the substantial associated risks (CDC 2024; Amato et al. 2021). 1.63 *million* middle- and high-school students currently use vapes containing nicotine on a regular basis (CDC 2024). Also, 63.9% of teens who vape report wanting to quit, and 67.4% have attempted to quit vaping within the past year (CDC 2024). Therefore, in this thesis my research question is, what factors worsen teens' vulnerability to vaping addiction and the associated harms?

Background Information: Why Vaping is Harmful to Physical and Emotional Health

Before vapes were introduced to the public market as a smoking cessation tool, national tobacco smoking rates were showing a promising decline (Gee et al. 2021). Vaping reversed this positive trend, and now more young people than ever are addicted to nicotine. One qualitative study used focus groups of 14- to 17-year-old teens to investigate their attitudes and familial norms with respect to vaping; in a subgroup of the young vape users who had no present interest in quitting, many participants reported that they would quit *if* vapes were found to be physiologically harmful in the future, and one young participant even said, "I'm only doing it now because apparently it's perfectly safe" (Alexander et al. 2019, p. 95). Also, more than one participant started vaping when their parents bought them a vape, because their parents knew

they had been smoking cigarettes and believed vaping to be safer (Alexander et al. 2019).

Furthermore, a significant portion of participants didn't understand the differences between vapes and traditional cigarettes with respect to nicotine content or other chemical content; many participants assumed that vapes do not contain nicotine at all (Alexander et al. 2019). These misunderstandings only benefit the vape industry while endangering public health.

Despite the popular belief that vaping is harmless, research shows that it actually has significant potential to cause physical harm (Kuntic et al. 2020; Tobore 2019). Vaping devices' lack of standardization makes consistent safety standards difficult to enforce, and different brands and flavors of vapes contain varying levels and types of chemicals. Vapes have been found to contain an alarming list of irritants and carcinogens, including formaldehyde, acetone, carcinogenic nitrosamines, heavy metals like nickel and lead, and more, and a rising number of recent deaths in the US have been associated with vaping-induced lung injury (Dinardo et al. 2019). In tests on humans and mice, it was found that "E-cigarette vapour exposure increases vascular, cerebral, and pulmonary oxidative stress... thus [having] the potential to induce marked adverse cardiovascular, pulmonary, and cerebrovascular consequences," and that there is evidence for a close connection to brain damage (Kuntic et al. 2020, p. 2473). The human brain continues to develop well into a person's twenties, and the developing teen brain is "particularly vulnerable to oxidative damage because of its high rate of oxygen consumption [and] sizable percentage of sensitive immature cells," and while e-cigarettes cause oxidative stress to a lesser degree than traditional cigarettes, the developing brain is so vulnerable that consistent e-cigarette use inducing continuous oxidative stress can have severe consequences on brain development (Tobore 2019, p. 203). Vape-induced oxidative stress is linked to many social maladjustments in teens, including "depression, suicide, sleep problems, cognitive impairment, attention deficits,

aggressive and impulsive behavior, [all of which] could seriously affect the success or failure of young people” (Tobore 2019, p. 203-204). Though vapes have been used in the United States for almost twenty years, their long-term health effects remain largely unknown.

All other potentially harmful chemical compounds in vapes aside, nicotine alone is detrimental and highly addictive, especially for young people: “Exposure [to nicotine] during adolescence negatively affects memory, attention, and emotional regulation, as well as executive functioning, reward processing, and learning” (Dinardo et al. 2019, p. 794). Most nicotine product use begins in adolescence, and tobacco product use as a whole is the leading cause of preventable disease, disability, and death in the United States (Gentzke et al. 2022).

All this aforementioned evidence shows vaping’s potential to be physically harmful to teens’ lungs and developing brains; research also extensively documents how vaping can be emotionally harmful to young people. Studies include heartbreaking testimonies from teen participants whose lives are deeply affected by their vaping addiction. In one study, teens shared that they felt ashamed, as though they were setting a bad example for others, that they were disappointing their families, that their interpersonal relationships were being affected, that their anxiety was compounded by vaping, that they hate the way it makes them feel about themselves... Teens reported that “[Vaping] is a distraction from everything else, it makes me feel like I’m not in control,” and that “I’m too young and it’s a stupid thing I never should have started” (Amato et al. 2021, p. 4). Also, since the CDC indicates that more than half of teen vape users want to quit, we must address this public health concern.

Methods

My thesis is a literature review of existing research on the topic of teen vaping addiction, with emphasis on why teens are particularly vulnerable compared to adults. Whenever “teens” are mentioned, the age group I refer to includes individuals between twelve and eighteen years of age. There are many reasons why teens are especially susceptible to vaping’s harms, and all reasons deserve consideration to form the best possible understanding of this public health problem. Most importantly, my review of existing discourse on this topic points to three major reasons teens are vulnerable: marketing targeted at young people, sweet flavoring appealing to young people, and teens’ decision-making capacity. While other factors adding to teens’ vulnerability have been identified and found mutual support between research projects, these three factors were most notable in the largest number of studies on the topic that I reviewed.

This body of research is relatively new; the only sources I cite from before 2015 pertain to teen decision-making with respect to tobacco products, not vaping. All other studies cited were conducted either in 2015 or more recently. During my research, I searched databases including SocIndex, Sociological Abstracts, and PubMed for applicable social science and public health studies, using search terms including *teen/young people vaping addiction*, *teen nicotine addiction*, *vape marketing/advertising/sales*, *vape flavor/flavoring*, and *teen vape decision/choice/rationale*. I followed citations in relevant articles to examine their discourse communities and discover further related research. I also pulled information from the Food and Drug Administration (FDA) and the Centers for Disease Control (CDC). In total, I reviewed over forty social science and public health research projects which were relevant to teen vaping addiction. In this thesis I cited sixteen of these studies, and four other sources including statistical and news information from the FDA, the CDC, and National Public Radio (NPR). I

chose to cite these specific twenty sources for their particular relevance to teens' vulnerability, though all the research I reviewed played a role in establishing the contours of this public health issue.

The research cited in this thesis pertains to the statistical prevalence of teen vaping addiction, the history of vape marketing and lawsuits, approaches taken by the FDA to curb teen vaping addiction, surveys and focus groups with teen vape users, and research which includes teens' personal testimonies about their experiences with vaping, because it seems to me that the most valuable evidence of teens' susceptibility and vaping-related suffering are their own perspectives. Ultimately, my hope is that all reasons teens are particularly vulnerable to vaping addiction can be addressed with urgency, and that public awareness can grow about the potential danger of vaping, especially for young people who lack the perspective and life experience to make a truly informed decision.

Marketing

For as long as they have existed in the US market, vapes have been marketed as a smoking cessation tool. Research and lawsuits have asserted that vapes were marketed to appeal especially to young people, and that this type of marketing is a contributing factor to the number of teen vape users (Hausman 2019; Striuk et al. 2020).

For decades, general tobacco product advertising has faced backlash for its deceptiveness. One example of this emerged in the 1950s, when a growing body of scientific literature claimed that using tobacco products significantly increased the risk of potentially fatal health issues, including lung cancer; in the midst of this criticism, "The tobacco industry responded by developing filtered cigarettes and advertising these products as a healthier

alternative... Advertising tactics such as labeling their cigarettes as ‘light’ or ‘low tar’ would result in decades of litigation as addicted consumers sought to hold the industry accountable for their deceptive marketing” (Hausman 2019, p. 224). This kind of dishonest advertising can mislead and harm anyone who uses tobacco products – especially young people. Other research from the nineties, before vapes existed in the United States, has shown cigarette advertisements have been aimed at youth consumers: “The battle of the [tobacco product] brands for market share is waged largely among the young, for it is a brand’s success among the young that leads to greater brand sales and profit in the long term” (Pollay et al. 1996, p. 13) – youth were not only the target of these cigarette advertisements, but sustained presence in the youth market is what keeps brands afloat and contributes most significantly to their financial success. This suggests a long-standing pattern of tobacco products being marketed towards young people.

Vape product advertising followed tobacco’s suit in terms of deceptiveness and appeal to teens, inspiring several notable lawsuits. One such lawsuit was brought against JUUL Labs in 2019. The JUUL device was designed in 2015 by two Stanford product-design graduate students who wanted to create a small device that could mimic the addictive aspects of smoking a cigarette. JUUL Labs quickly grew to a value of over \$15 billion, but came under scrutiny amid a growing body of research on vaping’s harms, and concerning statistics showing that use of the device was growing in prevalence among teens who had never smoked traditional cigarettes (Hausman 2019). Any vape use by teens who never smoked cigarettes is particularly problematic, because it completely defeats the originally claimed purpose of vapes as a smoking cessation tool, and places people in the way of all vaping’s potential harms for no beneficial reason. In *Colgate et al. v. JUUL Labs, Inc.*, plaintiffs alleged that even though the device had been marketed to them as a smoking cessation tool, it had made their nicotine addiction worse.

Plaintiffs also alleged that the corporation's advertisements, "which featured young, attractive models... were specifically aimed at convincing young people who were not previously cigarette smokers to purchase JUUL, to make the use of JUUL appear fun and without long-term negative consequences, to position the JUUL e-cigarette as the e-cigarette of choice for young adults, and to attract [teens] to the 'hipness' of using the JUUL product" (Hausman 2019, p. 230).

Since JUUL Labs was one of the first major vaping corporations in the United States, it faced some of the most severe backlash for its advertising methods. In the wake of this and other lawsuits, the corporation was forced to pay hefty settlements and change aspects of its devices' labeling and marketing. As a result, today JUUL devices have largely faded from the market and are more difficult to obtain than many other vape brands. Unfortunately, JUUL was just one example of deceptive teen-targeted marketing; other brands have mimicked their advertising approach. After the Colgate et al. lawsuit, advertisements from other brands examined in a scoping review were found to have similar characteristics: they emphasized their respective vape products' newness and innovativeness, and "were found to tap into almost all the reasons that youth cite for taking up e-cigarettes," and "the most highly cited reasons [for teens vaping] were most prominent in the ads" (Struik et al. 2020, p. 6).

Ads are often positioned to frame vaping as a less harmful alternative to smoking cigarettes (Richardson et al. 2015) – but the ads' effects contradict this idea. Many vape ads emphasize the innovativeness of their products by ridiculing the increasingly stigmatized cigarette: in these ads, vapes were being promoted as an easy nicotine fix, but since the ads were simultaneously setting vapes *apart* from cigarettes, their approach is "in direct opposition to the mandate that [vapes] are marketed as a cessation aid for cigarette smokers" – rather, vapes are being marketed for fun, carefree use (Struik et al. 2020, p. 6).

Long-standing research shows that teens are particularly susceptible to tobacco product advertising compared to adults, and more likely to make decisions based upon advertisements: a review found that “The relationship between brand choices and brand advertising is significantly stronger among teenagers than among adults,” and this finding about heightened ad sensitivity among young people is “consistent with the basic observations that [youths’] brand choices are highly concentrated on the brands most heavily advertised” (Pollay et al. 1996, p. 10-11), and in consensus with other previous research on youth ad sensitivity, especially with respect to tobacco products.

Ads for vapes, while not explicitly allowed by the FDA, are able to run on platforms and media where cigarette advertisements have been strictly prohibited. This renders these ads more prominently visible and accessible to youth. Many of the e-cigarette ads reviewed in one study were found on music and entertainment websites with up to 35% of their audiences under the age of 18 (Richardson et al. 2015).

Flavoring

There is a strong consensus in existing research about flavored vapes: a majority of teens in various research projects who initiated vaping indicate that they did so *because* of the appealing flavoring, or with flavoring as one of their biggest motivators. Of middle- and high-schoolers who currently vape, a staggering 87.6% use flavored vapes (CDC 2024).

A study examining teens’ rationale for their choice to vape revealed, “The number one most appealing factor for vaping identified... was the youth-friendly flavours and smells of the juice used in electronic cigarettes. There were many young people who stated that they would be unlikely to try electronic cigarettes if they did not have flavored options” (Caie et al. 2023, p.

90). Another study found that “Flavors were the most popular reason for trying [vaping for the first time], with most or all participants citing this reason and reporting that the first e-cigarette they used was flavored” (Alexander et al. 2019, p. 95). Another research project found that “79-81% of youth ever-users of e-cigarettes initiated e-cigarette use with a flavored product” (Pepper et al. 2016, p. 62), and “Interest in trying e-cigarettes was highest for fruit flavors, almost six times higher than interest in tobacco-flavored e-cigarettes” (Pepper et al. 2016, p. 64).

Because of the extensive research proving flavoring to be particularly attractive to teens, and a major risk factor in their decision to initiate vaping, the FDA forbids the sale of the vast majority of flavored vape products. The only flavored products that the FDA authorizes to be sold are a limited number of menthol- and tobacco-flavored vapes (FDA 2025); it may surprise you that zero fruity, candy, or sweet-flavored vapes are legally sellable or marketable in the United States. However, most vape stores or gas stations you visit will openly offer a rainbow of disposable vapes in various illegal flavors. In recent years, the FDA has made efforts to crack down on the import into the United States of certain illegal vape devices, and has also taken action by issuing warning letters to hundreds of brick-and-mortar stores found to be selling unauthorized vapes (FDA 2024). Unfortunately, these efforts have been mostly ineffective in curbing the widespread availability of illegal vapes. When one concerned mother caught her daughter vaping, she immediately began to investigate where these vapes were coming from; she quickly discovered that local authorities were uninterested in enforcing the law against illegal flavored vape sales. She escalated the issue all the way to the mayor of her city and found that nobody was willing to take action, even when she showed specific ordinances banning flavored vapes to the police (Noguchi 2023). One vape store owner who took the initiative to remove the banned vapes from his shelves pointed out that they are easily purchasable in countless other

stores, so unless the FDA “[gives] stores more clarity about *which* products are legal to sell, [or adds] funding for inspection, the rules will only apply to those willing to follow them” (Noguchi 2023).

Flavoring also contributes to misconceptions about vaping, which are exacerbated by deceptive marketing. A study found that many teens believed fruit-flavored vapes were less harmful (or harmless) compared to tobacco-flavored vapes (Pepper et al. 2016). A scoping review of vape advertisements found that many emphasized the satisfaction of flavored vapes, with phrases like “100% flavor” and encouragement to consumers to “‘draw’ and ‘taste’ the array of flavors” (Struik et al. 2020, p. 5).

The most valuable evidence of all comes from teens’ own perspectives, and in a focus group it was found yet again that flavoring was teens’ most popular reason for vaping: participants stated “‘You want to try every single flavor,’” and “‘It’s like you can have like one flavor in and then the next tank is a totally different flavor... The names are attractive, like Tiger Blood or Kryptonite or Space Jam Galactica’” (Alexander et al. 2019, p. 95).

Teen Decision-Making

Since their frontal lobes are in crucial stages of development, teens lack the rational decision-making skills that adults develop in their twenties. Existing literature points to two major reasons why the reality of teen decision-making places teens particularly at risk of vaping addiction. The first reason is that teens are especially prone to peer influence due to their heightened desire to fit in (Caie et al. 2023; Lippert 2019); the second is that teens are significantly more likely to take risks than adults, while lacking the capacity or perspective to understand the gravity of those risks (Reyna et al. 2006; Alexander et al. 2019; Strombotne et al.

2021). Because of these two realities, teens simply cannot make an informed decision about vaping.

Teens find themselves in a tumultuous stage in life, wherein they are prone to loneliness, anxiety, lack of confidence, and intense feelings of wanting to belong. Even if they are able to resist enticing vape flavoring and marketing that is targeted towards them, and even if they are part of the minority of vape users who are fully aware of vaping's harms, teens are much less likely than their adult counterparts to be able to resist peer influence. Research shows this is especially true if teens are struggling at home and experiencing family troubles: "...If [a young person has] poor relationships at home then their desire for connection with their peers may be even stronger. As a result, the young person may be more likely to use electronic cigarettes when their peer group carries a vaping culture as a way to fit in, or even to meet new people as this develops a sense of community... Those who vape often do it with their friends, therefore initiating vaping can be an easy way to find and interact with new friends" (Caie et al. 2023, p. 91). Also, while the research on teen vaping addiction is largely in consensus that enticing flavoring is the number one reason teens initiate vaping, peer pressure and influence is one of the most significant reasons too. An "overwhelming majority" of the quotes and data within one study showed that "peers play a large part in influencing young people to initiate their use of electronic cigarettes" (Caie et al. 2023, p. 89). Another study found that "As a learned behavior, initiating e-cigarette use is facilitated by peer modeling and demonstrations" and that over one-third of teens studied began experimenting with vaping because a vape-using peer had introduced them to the practice: "...when one member of a peer group acquires an e-cigarette, offers to use the device are soon made to other group members" (Lippert 2019, p. 1901). Furthermore, most teens who vape access their vape devices through their peers, including older

friends and siblings willing to purchase vape products for them (Alexander et al. 2019). This research largely ends in agreement: peer influence has a huge impact on teens with respect to initiating vaping addiction, and not only that, but teens' peers are also typically their access point for vapes, since due to their young age they cannot legally purchase vapes themselves.

Secondly, teens are more prone to risk-taking than adults, and their thought processes around risk-taking often fail to account for the true *gravity* of those risks, especially if risk-taking is not paired with immediate negative consequences. This is significant with the act of vaping, because it typically does not cause negative repercussions instantly, which can affirm teens' decision to continue: "Teens' overestimation of risk appears to decline after early adolescence, and evidence suggests that experience may be responsible: engaging in risk taking without incurring immediate consequences may encourage complacency" (Reyna et al. 2006, p. 62). On the contrary, focus groups exploring teens' reasons for vaping found that the immediate results of vaping in teens' minds tend to be positive: they report enjoying the flavors, doing tricks, and trying something new (Alexander et al. 2019).

Research on teens' rationale for vaping points to the crucial factor of optimism bias. Optimism bias in the context of vaping refers to when "a person systematically overestimates their own ability to quit [vaping] relative to the ability of other, similar people, even when they themselves might not have greater ability to resist addiction" (Strombotne et al. 2021, p. 3181). All humans have biases, and optimism bias in particular can naturally stem from innocent youthful immaturity. In a study that considered 1,610 teen responses, over 60% of respondents exhibited optimism bias and inflated confidence when describing their own ability to quit vaping; while naturally some teens will struggle less than others to quit, more than half the population should not be able to quit more readily than the US average teen, which indicates that

this excessive optimism is a fallacy (Strombotne et al. 2021). Other research identifies teen optimism bias as well: “[Teens] expect that future studies [about vaping] will show negative health effects and stated their intention to stop using e-cigarettes when these studies are available. However, they did not express awareness that they may not be able to easily quit using e-cigarettes at that point because of nicotine addiction” (Alexander et al. 2019, p. 96). Optimism bias can be identified in these studies because teens are underestimating the gravity of the risk of nicotine addiction – but as teens with teen brains, this is unsurprising: “Risk beliefs are a central predictor of many adult and adolescent health behaviors, including smoking. An important developmental difference is that, although adults treat some high-risk behaviors as categorically off-limits, adolescents weigh the pros and cons of even very dangerous activities” (Pepper et al. 2016, p. 65). And, teens are more likely to take any kind of risk than adults: “Teens tend to weight benefits more heavily than risks when making decisions. So, after carefully considering the risks and benefits of a situation, the teen brain all too often comes down on the side of the benefits – and chooses the risky action” (Reyna et al. 2006, p. 60). Also, research suggests that before vapes, “the trajectory from experimentation to addiction may have been longer” – vapes are far more discreet and also contain significantly more nicotine than cigarettes, meaning that it takes less time and fewer unwise “decisions” than ever before to create a nicotine addiction (Amato et al. 2021, p. 5).

All this research suggests that not only are teens particularly susceptible to peer influence compared to adults, but that peer influence is one of the most significant reasons teens try vaping for the first time. Also, since teens are more prone to taking risks than adults, especially risks like vaping that typically come with no immediate consequences, their innocently immature decision-making capabilities heighten their vulnerability to vaping addiction.

Discussion

The body of social science research on teen vaping addiction is relatively new, but strong consensus exists: a multitude of studies found that fruity flavoring is the number one reason teens initiate vaping, even though this flavoring is illegal; evidence from lawsuits, ad reviews, and focus group research shows that vapes have been marketed towards young people and that this marketing has been effective; and, on account of their youth and lack of life experience, teens are more likely than adults to take dangerous risks, more likely to succumb to peer pressure or influence, and less likely to understand the gravity of the risks they take, or the longevity of those risks' potential consequences. These were the themes that were most significant in my review of existing social science and public health literature on teen vaping addiction.

Nevertheless, one limitation that complicated my research on this topic is that many studies don't clearly differentiate between tobacco products, vapes, and THC devices. Even if a project was focused on some aspect of teen vaping addiction, the data was sometimes muddled by a lack of clarity in which specific devices and substances were being studied. Fortunately, much of that research was still applicable to the topic of vaping addiction (for example, the Pollay et al. 1996 study examining teens' heightened susceptibility to cigarette advertisements – these claims are mirrored in newer research about teens' susceptibility to vaping ads, indicating a longer-standing chain of evidence that teens are particularly susceptible to tobacco product advertising as a whole).

While vaping can be beneficial to some adults as a smoking cessation tool, teens are so much more vulnerable to vaping addiction's harms that they simply cannot make a truly

informed decision. The number of teens suffering from vaping addiction in the United States signifies a serious public health issue that demands urgent concern and attention.

Solutions to this public health issue are complicated. Much of the research cited in this thesis was done with the purpose of clarifying which approaches to curbing teen vaping addiction would be most effective – it is crucial to know *why* teens vape, where they acquire vapes, how much they truly know about vaping, how they feel about vaping addiction, why and whether they want to quit, and more. I wholeheartedly commend all of these researchers who have already been studying teen vaping addiction for many years; their work has been incredibly valuable to me in understanding why teens are particularly at risk of vaping’s harms. Their research is also indispensable to efforts to prevent teen vaping addiction, and to educate teens about potential harm in a relevant and effective way. Unfortunately, the FDA’s efforts to stop the sale of illegal flavored vapes have been short-lived and mostly ineffective; increased regulation of illegal vape imports and of vape stores’ inventories should be an immediate priority. Removing illegal vapes from the shelves is crucial, at least until they can be tested, regulated, and approved by the FDA. Continued research and increased regulation are necessary: we need to know how young people can be protected from vaping addiction until they have the age, tools, and understanding to make an informed decision for themselves.

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