Preventing E-Cigarette Use among Youth

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Abstract

In the United States (US), e-cigarettes may be the leading cause of preventable adverse health outcomes among the youth. Since the introduction of e-cigarettes in 2007, it has become the most popular tobacco product among the youth. E-cigarette use has been a severe public health concern, with one in nine high school students and one in 35 middle school students reporting e-cigarette use in the past 30 days. The present review highlights the e-cigarette use among US youth by providing comprehensive and sustainable evidence-based implementations to prevent e-cigarette use. A joint venture between parents, educators, youth advocates, and health care officials can combat the increasing e-cigarette use among youth. This review adds additional resources to the public health field by providing an in-depth understanding of e-cigarette use, reasons for the use, and best prevention strategies under one canopy.

Keywords: Youth; e-cigarette; Prevention; Epidemic

The extent of E-Cigarette Use among Youth

E-cigarettes have been among the most common tobacco products among youth since 2014. E-cigarettes are battery-powered devices that enable users to breathe in aerosols containing nicotine, flavorings, or other chemicals [1]. These devices may resemble a cigar, cigarette, pipe, pen, fillable tank, or USB drive. Currently, there are over 7,000 different e-cigarette types and 460 e-cigarette brands on the market [2,3]. As of 2021, about one out of 35 middle school students reported e-cigarette use in the past 30 days [4]. Similarly, one in nine high school students reported e-cigarette use in the past 30 days. The same report suggested that 34% of high school youth and 11.3% of middle school youth used tobacco products (i.e., e-cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, pipe tobacco, heated tobacco products, nicotine pouches, and bidis). Of these, 11.3% of high school students and 2.8% of middle school students reported using e-cigarettes in 2021[4].

There are several reasons noted for the growth in e-cigarette use among youth. The increased availability and accessibility of e-cigarettes at retail locations may have produced an environment responsible for smoking among youth [5]. The studies involving ecological perspectives regarding marketing, geographic distribution, and community-level behavior have observed an association with e-cigarette smoking initiation

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among adolescents [6-9]. Furthermore, adolescents who start smoking tobacco products or e-cigarettes before they are 19 are 2.4 times more likely to become heavy smokers than adults [10]. Hence, putting the adolescent population at an elevated risk of e-cigarette susceptibility.

Additionally, e-cigarette use varies across demographics such as sex, race/ethnicity, and sexual orientation [4]. Females (20.1%) compared to males (18.8%) report higher usage of e-cigarettes. Furthermore, white non-Hispanic youth report the highest (23.1%) usage of e-cigarettes, followed by Hispanic youth (17.6%), other non-Hispanic youth (12.7%), and black, non-Hispanic youth (12.6%). Youth identifying as lesbian, gay, or bisexual (14.2%) and transgender people (18.9%) are at elevated risk of tobacco use than their heterosexual youth (7.9%) and non-transgender youth (8.2%) [4].

The adverse effects of e-cigarettes on health are not entirely known. The prevalence of e-cigarette use may be highest among adolescents and young adults [11,4]. Contrary to the popular perception of e-cigarettes as a healthier option than traditional cigarettes, e-cigarette liquid contains toxins and carcinogens unknown to many people [12]. Additionally, e-cigarettes contain harmful chemicals such as formaldehyde, formaldehyde-forming hemiacetals, and toxins deposited on the surface [13].

Adverse Health Effects of E-cigarette Use

E-cigarettes can have adverse effects on the health. Research has shown that e-cigarettes contain chemicals and carcinogens that cause health problems [14]. These include nicotine, which may be addictive, ultrafine particles that can irritate the lungs when inhaled deeply, as well as flavorings such as diacetyl, a chemical linked to severe lung disease; volatile organic compounds; carcinogens; and heavy metals such as nickel, tin, and lead [15]. Although these substances are at lower levels than conventional cigarettes, they can still be hazardous [14,15].

Youth are susceptible to lifelong addiction and becoming conventional smokers because of the exposure to nicotine

content in e-cigarettes [16,17]. The nicotine exposure increases youth's dependence, leading them to engage in more vigorous and faster "kick" by switching to conventional cigarettes [18]. Also, studies demonstrate that young adults who use e-cigarettes may have a higher risk of converting into traditional cigarette smokers than their counterparts [16,17,19]. It has been reported that adolescents who have never smoked but have tried e-cigarettes will most likely attempt to smoke cigarettes in the future [20-22]. According to Vallone's (2018) study, young adults who vape nicotine are six times more likely to begin smoking cigarettes than those who have never vaped [20]. Beyond the risk of nicotine addiction, exposure to nicotine may be harmful to the brain, especially areas of the brain that are responsible for fixation, temperament, learning, and motivation control [23]. Additionally, e-cigarette use may impair the decision-making skills of adolescents. Studies have shown that nicotine detrimentally affects the prefrontal cortex part of the brain, which is responsible for decision-making, perception, concentration, planning, and perception [24] Northwestern Medicine, 2021, resulting in lifelong consequences.

Studies have shown that e-cigarettes significantly impact cardiovascular and lung disease, accounting for over half of all smoking-related deaths compared to conventional cigarettes [25,26]. E-cigarette users may be exposed to toxic substances such as acetaldehyde, acetone, acrolein, formaldehyde, and butanol, which may increase blood pressure, heart rate, diastolic and systolic readings [27]. Furthermore, these substances can also result in blood coagulation and atherosclerosis, detrimental to health [28,27]. Beyond the detrimental effects to the cardiovascular system, repeated exposure to acrolein may cause chronic pulmonary inflammation, reduced host defense, hypersecretion of mucus, and lung tissue damage that result in chronic obstructive pulmonary disease [29-31]. Occasionally, the vapor flavor may irritate the lungs, causing chronic inflammation and possibly cardiovascular disease [27].

Frequently e-cigarette users experience throat, eye, and skin discomfort because of the harsh chemicals it contains. Aerosols triggered by chemicals in e-liquid enter the user's lungs unfiltered and leave chemical residues therein. The aerosol droplets on surfaces increase the danger of second and thirdhand smoke, making it harmful to the user or others nearby [16,17].

Among young adults, the morbidity and mortality of e-cigarette users are increasing. Due to vaping, there is a continuous outbreak of significant lung illness and death among youth (2,807 reported cases and deaths as of February 18, 2020). Of these 2,807 reported cases and deaths, 15% of patients were under 18 years old, and 37% of patients were 18 to 24 years old, thus, contributing to the nation's hospital emergency visits and health costs [32]. Apart from lung injury cases or deaths linked with e-cigarettes or vaping products, E-cigarette liquids have also been associated with poisoning cases among youth [33].

Many young adults are unaware of the health consequences of E-cigarettes. They are mostly unaware that vaping cartridges contain nicotine and often believe that e-cigarette pods only have flavoring [34]. In this respect, the alluring commercials, the invention of a variety of fashionable e-liquid flavors, the widespread availability of these products, the combination of different e-liquid flavors, and the expectation that e-cigarettes reduce smoking's harmful consequences have all added to making these devices appealing to this population [35,36].

Factors and reasons contributing to youth e-cigarette use

Several factors contribute to the widespread use of electronic cigarettes by youth. These factors include but are not limited to a choice from an array of flavors, cost-effectiveness, ease of accessibility and use, and the impact of social media [37].

An array of flavors

According to Ambrose et al. (2015), most youth who use e-cigarettes initiate with a flavor. A variety of flavors makes e-cigarettes desirable among the younger generation [38]. Flavors such as candy floss, cinnamon, chocolate, vanilla, bubble gum, and mint make e-cigarettes appealing [37]. The 2020 National Youth Tobacco Survey showed that 82.9% of current e-cigarette users used flavored products, including 84.7% of high school users (2.53 million) and 73.9% of middle school users (400,000) [39]. Additionally, a 2019 Truth Initiative survey demonstrated that high school students' mint and menthol flavor use rose from 16.7% in 2016 to 57.3% in 2019 [40]. Mint or menthol e-cigarettes appeal more to high school (67.5%) users than tobacco-flavored e-cigarettes [40].

Cost-effective

A pack of traditional cigarettes costs about $7.26 in the US in 2015, so smoking one pack per day for a year would cost $2650. On the other hand, smoking e-cigarettes (cartridge models) would cost approximately $1000 [41,37]. An e-cigarette cartridge typically costs $15-20 for the 30-milliliter cartridge, with each milliliter of liquid delivering about six milligrams of nicotine to the smoker. One milligram of nicotine costs about 15.7 cents for traditional cigarettes, but for e-cigarettes, it only costs 10 cents [42]. Furthermore, e-liquid is even cheaper to use at an average of $511 per year. Therefore, e-cigarettes may be much more cost-effective than regular cigarettes.

Ease of accessibility

E-cigarettes are promptly available in shopping mall kiosks and can be bought with a single click on the internet, where most adolescents spend most of their spare time [43]. Coupled with the ease of buying and affordability, these vaping devices are convenient because they do not produce a heavy tobacco odor [37]. Nonetheless, the devices are easy to use as they are frequently disguised as flash drives and easy to stow away from teachers and parents [44]. In addition, many young vapers believe that smoke-free laws do not apply to them, and therefore they have the freedom to vape in any smoke-free setting [45]. Some

states include e-cigarette smoking in smoke-free regulations, but many do not, complicating the problem [37]. A study indicates that almost 60% of vapers (three- third were between 18 and 29) do so in smoke-free environments such as workplaces, malls, cafes, movie theaters, and hotels [46].

Impact of social media

Young people are also influenced by social media, which has brought these electronic devices into the limelight. A study conducted in 2018 found that social media advertisements with e-cigarette ads were related to positive expectations of e-cigarette use, such as the idea that it would provide a delightful taste and smell and be safe and socially acceptable [47]. In this regard, JUUL (one of the e-cigarette makers) have taken the lead in marketing to young people through social media, including Facebook, Instagram, Twitter, and YouTube. One vaping influencer was paid $1,000 for a blog post about JUUL. JUUL has an entire department dedicated to influencer marketing and looks explicitly for people under 30 and a "VIP Portal" for celebrities. [40].

Big tobacco companies have worked with organizations, like the e-cigarette association, the smoke-free alternatives association, and Vapers International, to delay or eliminate legislation to restrict e-cigarette sales and use [48]. Further, several websites and web enthusiasts promote e-cigarettes, claim that e-e-cigarettes are less harmful and healthier than traditional cigarettes [35]. A sense of coolness portrayed by models who smoke e-cigarettes is also a big influence on young minds.

Social/Cultural Considerations

Young people exposed to peer pressure and social support in their schools and societies have developed a community of vapers due to the popularity of e-cigarettes [49]. Furthermore, e-cigarette use has turned into a culture where vapers, including teens, lead stunts and facilitate competitions centered on events such as blowing huge and various vape rings and sizes [38]. Also, borrowing and sharing e-cigarette devices might aid the formation of a person's social vaping identity [43]. Since vaping products and flavors are easy to share and rent, young people consider it a causal commodity. In addition to the former, many social media accounts, websites, and YouTube channels promote the vaping lifestyle, while some have over a million followers [46].

Assumptions of Vaping as Low-Risk

Youth assume that e-cigarettes are less dangerous than conventional cigarettes [50]. Although vaping does not involve combustion, many youths believe that nicotine vaping is less harmful than smoking because it does not emit tar or carbon monoxide [51]. Some e-cigarette users believe that vaping does not adversely impact lung health like smoking, whereas others consider it a risk-free alternative to smoking [52-54]. However, these assumptions are incorrect because of the severe health risks of vaping [46].

Regulatory Environment

Regulations governing vape products are constantly evolving. The 2009 Tobacco Control Act provided the FDA with the power to initialize code on tobacco products, including cigarettes, roll-your-own tobacco, smokeless tobacco, and all other products that deem to be subject to the law [55]. In January 2020, the FDA prohibited e-cigarette flavors, but it does not cover all flavors. The ban applies to all flavors vapes except menthol and tobacco for non-disposable cartridge or pod-based systems, including tank systems, disposable e-cigarettes, or any flavored e-liquids in pod form. However, this policy is not comprehensive and loaded with flaws, permitting thousands of flavored e-cigarettes to remain available in the market [56].

Similarly, state, and local governments may have the authority to pass laws restricting access to and availability of e-cigarettes and vaping devices. For example, at the federal level, vaping cannabis products containing 0.3% or less THC is legal, while concentrations of more than 0.3% are illegal [46]. The complex and continuously evolving environment make the oversight of vaping devices and products increasingly challenging, especially at the state and local level.

E-cigarette Prevention Strategies

Although e-cigarette use has reached an epidemic level among the youth, it is preventable through various strategies [57-59]. Implementing a sustainable population-based strategy combined with the regulation efforts on tobacco products by FDA can help prevent and reduce all forms of tobacco use among youth [4,26,59,50,60]. Furthermore, the initiation and prevalence of e-cigarette use among youth can be combated through mass media campaigns and comprehensive statewide tobacco control programs [59].

Several prevention strategies have been developed and implemented to reduce e-cigarette use among youth. The strategies are multi-level. Firstly, parents, guardians, teachers, mentors, tutors, health experts, religious leaders, and other influencers should be trained whose guidance and eminence influence youth decisions on the dangers of e-cigarette use. Also, influencers should help with engaging youth in meaningful conversations concerning the health effects of e-cigarette use. Parents and other older adults can assist young people in becoming less addicted to e-cigarettes by conversing with their teenagers or other young people about the harms of using e-cigarettes. Watching or sharing educative videos on the risks of e-cigarettes with friends and other young people is often a terrific way of starting a conversation. Two different strategies for keeping away nicotine and other contaminants that might be dangerous to one's health include avoiding restaurants and cafes that allow e-cigarettes and informing business entrepreneurs and owners who permit e-cigarette use indoors that it is not as safe as pure air. Preventing or banning family members, friends, and visitors from using any e-cigarette or smoking product in the household or cars is another crucial step in protecting young

people from secondhand aerosol and e-cigarettes. Also, health educators need to advocate for regulations and laws that prohibit the use of e-cigarettes in schools [61].

Youth e-cigarette interventions and programs

Several youth e-cigarette evidence-based interventions have been developed to address this public health issue. A few of these interventions include smokeSCREEN, The Real Cost Campaign, and CATCH My Breath. The following paragraphs provide descriptions and findings of these programs.

SmokeSCREEN

smokeSCREEN has the avoidance of smoking and vaping as its objectives. This intervention is an online videogame that can be played on any device or smartphone connected to the internet. The videogame is accessible for free from the Google Play and Apple App Store. smokeSCREEN is a videogame made by Yale University's play2PREVENT Lab to assist teenagers aged 10 to 16 quit smoking and vaping. Findings of an evidence study showed that brief exposure to smokeSCREEN has a good effect in reducing the risk of adolescent smoking and vaping. According to the evidence findings, the videogame changed people's risk perspectives and beliefs about e-cigarettes and other tobacco products. This video game implies that players can assist themselves in navigating scenarios including tobacco usage, such as e-cigarettes or nicotine smoking. The videogame can be in various sessions ranging from 30 to 60 minutes and takes about 3 hours to complete the whole game. The timeframe between the videogame completion and follow-up ranged from 2 to 12 weeks [46,62].

The Real Cost Campaign

In 2014, the FDA established the Real Cost Campaign to educate at-risk teenagers about the dangers of cigarette smoking throughout the United States. The campaign extended its advertisements to cover e-cigarettes in the Fall of 2018. These campaigns enlighten the youth about the actual cost of smoking by educating them about the dangers of using e-cigarettes through television advertisements, streaming video ads, social media, youth-targeted blogs, and other media accounts. Findings from the Real Cost initiatives indicated that "high exposure" to campaign advertisements, as against "low or no exposure," was associated with a 30% lower risk of youth starting to e-cigarette smoke. The campaign is focused on more than 10 million US teens aged 12 to 17 who have used or have a keen interest in using e-cigarettes. The campaign received about 2 billion teen streams, 578,000 likes, 89,000 shares, and 31,000 tweets in the first 9.5 months [55,46].

CATCH My Breath

CATCH My Breath e-cigarette, and JUUL preventive program was created by the University of Texas Health Science Center Houston, School of Public Health. The program is developed to educate students in grades 5 through 12 on the harmful effects of nicotine vaping and tobacco use. It provides teachers, guardians, parents, and health providers with detailed information so that students have the skills and abilities to make better decisions on e-cigarette use. The program course has four lessons for each grade level (about 30 to 40 minutes): classroom lectures, physical fitness strategies, and parent education. Over a four-week timeframe, the program software is expected to be used once a week. Research uncovers that the CATCH My Breath program reduced nicotine vaping usage over time and within the last month [63,46].

Gaps in Youth E-cigarette Interventions and Programs

Although prevention and cessation programs broadly include vital components known to be effective, some gaps exist. For most programs, e-cigarette prevention and cessation modules are not separated from general tobacco prevention and cessation modules. Thus, there are differences in the duration of exposure to prevention content and mode of delivery, thereby making it difficult to compare the efficacy of programs with one another. Further, several programs are not updated or include the latest e-cigarette products that youth use. There is also less information about e-cigarette cessation programs. Moreover, some prevention programs have evaluated their entire curricula or tobacco prevention efforts, but not specifically their e-cigarette components. When evaluation studies are conducted, the program's long-term impact, such as e-cigarette education leading to decreased or increased youth e-cigarette use, is rarely known [64].

Recommendation and Conclusion

Health educators are encouraged to utilize free e-cigarette CDC resources to learn about the different types and sizes of e-cigarettes and explore the risks of e-cigarette use among young adults. This could help involve youth in meaningful conversations and provide factual information by eradicating common myths. Given the growing rate of e-cigarette addiction among young adults, health education and mass media campaigns (TV, mail, print, and outdoor advertising), as well as social media communications (websites, social networking sites, blogs, and e-mail) about a tobacco-free lifestyle, should be pursued endlessly. Furthermore, addressing the gaps between existing prevention and cessation programs requires intervening systematically by involving schools, parents, teachers, and the community. Intervention programs need to address the factors most likely to influence adolescent use of e-cigarettes, include more information about e-cigarettes' impact on mental health, describe their programs for ease of replication, and evaluate their programs. More effective and evidence-based tools, resources, and programs are needed for adolescent e-cigarette cessation.

Since the long-term health effects of e-cigarette use are unknown, there is a need for continuous information and awareness about the probable dangers of e-cigarette use accessible to the youth. For instance, e-cigarettes can lead to

nicotine addiction, damage brain growth, and encourage tobacco use [65]. Future studies should investigate the characteristics of e-cigarette devices, the detailed components of e-liquids, and user preferences that include nicotine and other contaminants. Future research should examine the scientific long-term benefits and risks of using e-cigarettes [57-60]. Further research is needed to understand how various features of e-cigarettes contribute to possible harmfulness. In addition, future research could explain how the composites in e-cigarettes are impacted by heat or go through changes in chemical composition. Similarly, research should determine whether these composites are retained in the blood circulatory system. Research efforts should determine whether probable health hazards can be mitigated by improvements in product engineering.

This overview contributes to the literature on current e-cigarette use among youth by providing an insight into the extent of youth e-cigarette use, factors and reasons associated with use, and the youth e-cigarette use, prevention strategies, and recommendations for public health field. Youth and young adults should be educated concerning the risks of e-cigarettes and the chances of getting addicted for the rest of their lives. It is crucial to develop a long-term plan addressing the prevention of e-cigarettes, considering the dangers of electronic cigarettes for young adults. This can be accomplished by advocating for strict policies and programs at the federal, state, and local levels that make it possible to avoid e-cigarette use and at the same time, restrict the use of e-cigarette among youth.

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