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REVIEW ARTICLE

The New Generation E-Cigarette Pandemic Threatening Youth: Puff Bars

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SUMMARY

Disposable e-cigarettes, which come under many different brands and varieties, are generally known under the brand name Puff Bar, which was the first product released. These disposable products contain high levels of flavors and synthetic nicotine and now play an important role in introducing young people to tobacco products and in the spread of nicotine-type addiction in society. This review examines disposable e-cigarettes and the factors influencing their popularity among young people, based on existing literature. Articles regarding disposable e-cigarette usage among adolescents and young adults were searched and reviewed using PubMed, ScienceDirect, and Google Scholar. Their flavors, low cost, vibrant colors, and easy availability make Puff Bars and other disposable e-cigarette products attractive to young people. These types of Electronic Nicotine Delivery Systems (ENDS) products contribute significantly to the use of nicotine-containing products by young people who have never smoked and to the development of nicotine addiction. This review provides detailed information about the reasons for new generation e-cigarette use in light of findings from various studies conducted with young people and emphasizes the importance and necessity of new toxicity studies on disposable e-cigarettes, synthetic nicotine, and flavors.

Keywords: *Puff Bar, Disposable e-cigarette, Young, E-cigarette, Flavorings.*

Gençleri Tehdit Eden Yeni Nesil E-Sigara Pandemisi: Puff Barlar

ÖZ

Birçok farklı marka ve çeşidi bulunan tek kullanımlık e-sigaralar, genellikle piyasaya sürülen ilk ürün olan Puff Bar marka adı altında bilinmektedirler. Tek kullanımlık bu ürünler yüksek düzeyde aroma ve sentetik nikotin içermektedirler ve gençleri tütün ürünleriyle tanıştırmada ve toplumda nikotin tipi bağımlılığın yayılmasında önemli bir rol oynamaktadır. Bu derlemede, tek kullanımlık e-sigaralar ve gençlerin tek kullanımlık e-sigaraları tercih etmesine neden olan faktörler mevcut literatür ışığında değerlendirilmiştir. Ergenler ve genç yetişkinler arasında tek kullanımlık e-sigara kullanımına ilişkin makaleler PubMed, ScienceDirect ve Google Scholar kullanılarak aranmış ve incelenmiştir. Aromaları, düşük maliyetleri, canlı renkleri ve kolay bulunabilmeleri Puff Bar'ları ve diğer tek kullanımlık e-sigara ürünlerini gençler için çekici hale getirmektedir. Bu tür Elektronik Nikotin Taşıyıcı Sistem (ENDS) ürünleri, hiç sigara içmemiş gençler tarafından nikotin içeren ürünlerin kullanılmasına ve nikotin bağımlılığının gelişmesine önemli ölçüde katkıda bulunmaktadır. Bu derlemede, gençler üzerinde yapılan çeşitli çalışmalardan elde edilen bulgular ışığında yeni nesil e-sigara kullanım nedenleri hakkında detaylı bilgi verilmekte ve tek kullanımlık e-sigaralar, sentetik nikotin ve aromalar üzerinde yeni toksisite çalışmalarının önemi ve gerekliliği vurgulanmaktadır.

Anahtar Kelimeler: *Puff Bar, Tek kullanımlık e-sigara, Gençlik, E-sigara, Aroma vericiler.*

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INTRODUCTION

The increase in nicotine consumption, which began with the invention of the tobacco rolling machine in the 1880s, is now successfully adapting to the new world order with the use of electronic systems. Jerzyński and colleagues estimated that between 2012 and 2023, the number of e-cigarette users worldwide would quadruple from 21.3 million to 86.1 million. When this figure was determined, products called "Puff Bars," currently the most popular e-cigarette product in all societies, were not yet on the market (Jerzyński et al., 2021).

E-cigarettes are the most important member of the new electronic nicotine delivery systems (ENDS) and cover a wide range of products currently on the market. Today, e-cigarette types can be grouped into four basic categories (Mercier et al., 2024) from those that look like cigarettes, pens, or USB drives to somewhat larger products like "personal vaporizers" and "tank systems" (pods). Additionally, the ENDS are sold in many flavors. For these reasons, the product range of e-cigarettes is diversifying and changing constantly.

Puff Bars, launched in 2019, is an e-cigarette brand whose cartridges cannot be replaced, unlike other fourth-generation pod products such as JULL (non-disposable cartridge-based ENDS) (Majmundar et al., 2023). These disposable e-cigarette products are increasing in usage very rapidly, especially among young people in every corner of the world, and contain various flavors. The brand name 'Puff' and the cloud logo appear on flashy and attractive devices of different sizes, containing e-liquid volumes with different amounts of nicotine. The company that produces the Puff Bar brand has many varieties, such as "Puff Bar, Puff Mini, Puff Plus, Puff XXL, Puff Krush, Puff Stig, and Airis Puff". Many disposable e-cigarette brands produced by multiple purveyors (such as Vuse Go, Elf Bar, Lost Mary, SKE Crystal, Saltica S-Phone, BLVK, Cloud Nurdz, and Syn Bar) have begun to appear on websites. For example, in the U.S., according to the 2023 National Youth Tobacco Survey (NYTS), the most frequently reported brands by student e-cigarette users were Elf Bar (56.7%), Esco Bars (21.6%), Vuse (20.7%), JUUL (16.5%), and Mr. Fog (13.6%) (Birdsey et al., 2023). Disposable e-cigarettes are available on the market in many different flavors, including fruity, fruity-menthol, menthol, tobacco, and candy (Dai & Hao, 2022; Ramamurthi et al., 2023). All of these varieties contain strong nicotine salts at doses of 50 mg/ml or higher. Most non-refillable e-cigarettes are made in China (Ramamurthi et al., 2023). An average Puff Bar, which was launched two years ago, is no longer usable after approximately 400 puffs (about 40 cigarettes), while some recently produced disposable e-cigarettes last up to 100,000 puffs.

On December 18, 2018, the U.S. Surgeon General declared an "e-cigarette epidemic" because e-cigarette use among American high school students increased from 1.5% to 27.5% from 2011 to 2019. As a result of the 2019 NYTS and other reports on youth tobacco use, the FDA took action to end this epidemic by raising the federal minimum age for the sale of tobacco products (including e-cigarettes) from 18 to 21 in December 2019 and prioritizing enforcement against illegal flavored (e.g. fruit) e-cigarettes (FDA, 2021). The FDA later banned flavored (except menthol and tobacco flavors) and cartridge e-cigarettes in February 2020. On the other hand, the company that produces Puff Bar products announced that it voluntarily withdrew from the online sale and distribution of its products. Due to these effective regulations, e-cigarette sales, excluding non-refillable e-cigarettes, decreased between August 2019 and May 2020. The company that produces Puff Bars re-launched its Puff Bar products in February 2021, claiming that they use "tobacco-free nicotine" in their products, that is, "nicotine not derived from tobacco", and that their products do not contain tobacco or any substances derived from tobacco. Thus, non-refillable e-cigarettes like the Puff Bar have come to the fore after the ban on cartridge and flavored e-cigarettes.

In April 2021, Puff Bar became the most popular disposable e-cigarette brand in the U.S., taking nearly half of the e-cigarette market share in the U.S. (51.3%) (Truth Initiative, 2021).

While 2019 U.S. NYTS data showed that the most frequently used ENDS brand by youth was JUUL (Anic et al., 2021), in 2020, 26.1% of high school students and 30.3% of middle school students reported that the e-cigarette brand they used was Puff Bar. It was determined that JUUL use declined among students quickly (5.7% of high school students and 12.5% of middle school students). Of the 82% (2.53 million) of American high school students who used e-cigarettes in 2020, most used fruity, menthol, and sugary flavors. According to the 2023 U.S. NYTS, disposable e-cigarettes are the most popular device type among e-cigarette users (60.7%), followed by pre-filled or refillable cartridges or pods (16.1%), and mod systems or tanks were the last choice of youth at 5.9% (Birdsey et al., 2023). According to the latest 2024 U.S. Youth Survey of middle and high school students, e-cigarettes are the most commonly used tobacco product among U.S. youth (5.9%). Between 2023 and 2024, e-cigarette use decreased among all students (from 2.13 million to 1.63 million students). This decrease was most notable among high school students, while there was no change in the rate of e-cigarette use among middle school students (Jamal et al., 2024). On the other hand, it is estimated that sales of disposable e-cigarettes in Switzerland may have increased by 2200% in 2022 (Ruggia, 2022). It is difficult to access statistical information on the rates of disposable e-cigarette use in countries around the world due to the lack of a sufficient number of studies.

METHOD

Words such as Puff Bar, disposable e-cigarette, young, e-cigarette were used to search for articles via search engines (ScienceDirect, PubMed, and Google Scholar). Using these keywords, research articles and letters to the editor published especially in the last decade were identified and examined.

RESULTS

Why are youth using e-cigarettes?

The pleasant smell of e-cigarette vapor: Flavoring agents used in e-cigarettes today play an important role in increasing Puff Bars use, especially among adolescents. The popularity of these products is increasing due to their wide range of flavors and options that appeal to many different tastes. In fact, young people who use e-cigarettes usually associate their starting/trying e-cigarettes with the thousands of "flavors" they contain, and they cite the attractive flavors of e-cigarettes as the primary reason they began (Ambrose et al., 2015).

One of the expected results of tobacco addiction is that young people who start using tobacco products by trying a flavored product will most likely switch to other tobacco products. Young adults use e-cigarettes such as Puff Bars because e-cigarettes contain various flavorings, and these flavored products are more addictive than tobacco flavors. According to a 2016 report from the Behavioral Risk Factor Surveillance System survey, 44.3% of young adult (18-24 years old) e-cigarette users had never smoked before trying e-cigarettes in the U.S. (Mirbolouk et al., 2018).

Flavorings and synthetic coolants are used in ENDS products at higher levels compared to other consumer products, such as in edibles (e.g., beverages, chewing gum, and baked goods) and cosmetics (e.g., soaps, lotions, and perfumes) (Omaiye et al., 2019; 2022). For example, the concentration of ethyl maltol, which imparts a sweet flavor, in Puff liquids ranges from 0.007% to 0.99%, exceeding ingestible concentrations in 77% of products tested (Behar et al., 2021; Omaiye, 2022; Tierney et al., 2016).

Product manufacturers are increasing the amount of synthetic flavorings and menthol in ENDS to appeal to young people, while completely ignoring the potential health risks of inhaling these substances. On the other side, our knowledge of the chemical structures and toxicities of new compounds that may be formed, especially when flavorings are heated, is in

its infancy (Cok, 2023). Flavored e-cigarette users also have lower intentions to quit e-cigarette or tobacco use (Dai & Hao, 2016). Therefore, we need more information about which chemicals from ENDS use pose a threat to youth and how they can be controlled.

Presenting products in attractive shapes and colors, and product accessibility: Puff Bars primarily attract the attention of young people due to their colorful and eye-catching packaging. New products that are released are one step ahead of previously released products with their eye-catching appearances. The striking colors of these products are one of the prominent features that make them noticeable to young people. These products are also gaining the attention of young people in terms of incorporating technological features such as digital displays.

The low cost of Puff Bars makes them affordable. Depending on the user's usage habits, Puff Bars can be used for a few days to a few weeks, which also makes the products affordable and effective, thus appealing to young people. Puff Bars can often be purchased for a low price online from e-cigarette shops, gas stations, etc., and used for a few days and then thrown away (Rosenthal et al., 2022). Considering that young people have lower budgets, the price ranges of these products are attractive to them. The widespread sales of these products over the internet make it easier for teenagers to purchase these products, as it is difficult to check the age of minors online (Josseran et al., 2023).

Convenience and perceived privacy of vaping and using: Puff Bars are pre-charged and pre-filled e-cigarettes. This provides simplicity and ease of use for users, which is one of the main reasons why Puff Bars and other disposable vapes are preferred by young people.

Unlike JUUL, Puff Bars are not refillable and run out quickly, which is why teens tend to throw them away after use. These devices are similar to USB flash drives; they do not take up much space in the pocket. In addition, due to their small size, adolescents can easily hide their e-cigarette usage habits from their parents, families, and those around them (Rosenthal et al., 2022; Ruggia, 2022).

Inadequate recognition of risks: Another important reason for the increasing interest in Puff Bars among young people is that they think that disposable e-cigarettes are healthier than regular cigarettes. Young people think that e-cigarettes are a way to get rid of a nicotine addiction. This situation is valid not only for young people but also for many adults who use e-cigarettes. Using e-cigarettes to get rid of nicotine addiction is not one of the treatment methods recommended by any health authority. On the contrary, it is an important use that plays a role in keeping nicotine addiction alive. For this reason, and for young people to think in this way, they are at a greater risk of e-cigarette addiction.

Disposable e-cigarettes often contain higher levels of nicotine compared to other e-cigarette products, such as JULL (Tan and Weinreich, 2020). High nicotine levels play an important role in the development of nicotine-type addiction. Thus, it is very likely that a nicotine-type addiction that begins with these products will turn into other tobacco product use and expand to different dimensions. It is also stated that young adults have difficulty adequately understanding the potential risks of e-cigarettes.

Nicotine exposure during adolescence through smoking or using e-cigarettes may be detrimental to brain development, affecting neural connectivity in the central nervous system, affecting information processing, and impairing cognitive function, attention, and short-term memory (Dubrosa et al., 2023). Although Puff Bars contain synthetic nicotine, this type of nicotine has the same chemical and biological properties as tobacco-derived nicotine. Adolescent nicotine use may increase the risk of addiction to other drugs, including increasing the risk of marijuana use and alcohol dependence (Audrain-McGovern et al., 2018). Because nicotine is

as addictive as heroin and cocaine (Choi et al., 2021), the earlier a person starts using nicotine, the harder it is to quit later in life, as these people are more vulnerable to nicotine addiction. This also applies to e-cigarette users under the age of 25 because their nervous systems and brains are still developing. Nicotine is also considered a gateway drug for illicit drugs, including methamphetamine and cocaine (Ren & Lotfipour, 2019). Additionally, e-cigarette use in adolescents has been associated with an increased risk of initiating conventional cigarette smoking (Soneji et al., 2017).

High-volume CBD vaping products in commerce: ENDS have been modified for nearly a decade to deliver illicit substances beyond nicotine, such as Δ9-tetrahydrocannabinol (THC), cannabidiol (CBD), and certain drugs. CBD is the main cannabinoid component in hemp. The market for CBD-based products has been growing rapidly, especially in recent years. CBD is a non-psychoactive cannabis active ingredient approved for a variety of ailments, including pain management and epilepsy (Epidiolex) via oral administration. Smoking CBD-dominant cannabis strains or vaporizing CBD oil is the fastest way to experience the effects. Vaporizing CBD via e-cigarettes and its effects are unregulated and insufficiently researched by health authorities. The prevalence of CBD vaping is increasing globally, especially in the U.S. and Europe. In fact, the market size of CBD e-liquids is expected to reach $74 billion by 2030, up from $3 billion in 2022 (Data Bridge Market Research, 2023). Flavored or unflavored CBD e-liquids are sold in online stores with a wide range of cannabidiol-infused CBD vaporizer options in various strengths and sizes. This provides an extremely suitable environment for adolescents to try CBD-containing products and expand their experience. In other words, e-liquids containing THC and CBD play an important role in the spread of e-cigarette usage. In the U.S., as of 2022, approximately 19% of adult e-cigarette users (Dai et al., 2023) and 21% of adolescent (11-18 years old) e-cigarette users (Goodman et al., 2022) are also vaping CBD. Recent studies have shown that vaping CBD causes a proinflammatory response in the lungs of mice, creating pathologies similar to those seen in smoking-related diseases (Bhat et al., 2023). In August 2019, the most significant e-cigarette or vaping product use-associated lung injury (EVALI) in the U.S. occurred affecting 2,807 people, primarily adolescents and young adults. It caused 68 deaths and was associated with vaping e-liquids containing THC, vitamin E acetate, and medium-chain triglycerides (CDC, 2021). A very recent study showed increased toxic emissions of formaldehyde, acetaldehyde, acrolein, diacetyl, and methylglyoxal in CBD vapor emissions (Robertson et al., 2024).

Marketing models and programs aimed at youth: One of the reasons for the increasing popularity of Puff Bars is that young people interact on social media platforms like TikTok, where one-third of the 49 million users in the U.S. are under the age of 14. Although minors are prohibited from using alcohol, drugs, or tobacco on social media platforms like *TikTok* or *Instagram*, Puff Bars are being popularized by platform users and targeted advertising. According to a study, when young people are exposed to e-cigarette-related posts shared by their peers on social media, their tendency to use e-cigarettes increases.

Adolescents and young adults in particular tend to perceive social media influencers as role models. This can result in more positive perceptions and intentions to purchase or use products promoted by social media influencers. Young people believe that they become COOL by purchasing COOL products (Lee et al.,2024). When following social media influencers with e-cigarettes, adolescents prefer *TikTok* and *Pinterest* more frequently, while young adults use *Twitter* more frequently.

Less perceived health risk due to lower temperature evaporation process: While the variety of chemicals in e-cigarette aerosols is being determined by an increasing number of studies, it is also revealed

that there is inevitably exposure to carcinogenic chemicals from these products. It has been reported that e-cigarette use results in lower levels of exposure to toxic compounds such as tar, carbon monoxide (CO), benzene, lead (Pb), nickel (Ni), and arsenic (As) than those encountered in traditional cigarette use (Eshraghian & Al-Delaimy, 2021; Gray et al., 2022; Lu et al., 2021). On the other hand, e-cigarette users have higher biomarker concentrations of some metals (e.g., cadmium and selenium), volatile organic compounds (e.g., acrolein, acrylamide, and acrylonitrile), and propylene glycol compared to non-users. Exposure to carcinogenic chemicals (e.g., benzene and chromium) may also be higher in e-cigarette smokers than in non-smokers (Raj et al., 2020; Szukalska et al., 2020). It should also be noted that some carbonyl compounds, such as acetaldehyde, formaldehyde, and acrolein in e-cigarette aerosols are also produced by thermal decomposition of e-cigarette cartridge content and are classified as carcinogenic (IARC, 2021; Li et al., 2021). We also have little information on the toxicity profiles of new chemicals originating from flavoring additives in e-liquids.

Exposure to such chemical compounds can lead to various health risks, especially cancer. For example, inhalation of e-cigarette aerosols can cause toxicity in oral cells, the first exposure site, and may have the potential to induce oral cancer. It is suggested that exposure to e-cigarettes can cause adverse effects on oral health, including changes in the oral microbiome, inflammation, dysbiosis, periodontal diseases, and deterioration of teeth and gum health. Exposure to e-cigarettes has also been found to have toxic effects on head-neck and mouth cells in terms of abnormal morphology, decreased viability, oxidative stress, delayed fibroblast migration, cytotoxicity, and genotoxicity (Szukalska et al., 2020; Wilson et al., 2022). These health risks posed by e-cigarettes carry similar potential risks for Puff Bars.

Puff bar products, the most important family of 4th-generation e-cigarette products, have rapidly spread from their initial launch in the United States to various continents and countries around the world, finding increasing numbers of new users in various regions such as Canada, the United Kingdom (Hammond et al., 2025), Australia (Jongenelis, 2023), Switzerland (Ruggia, 2022), and China (Ramamurthi et al., 2023). These products have rapidly reduced the use of their predecessors, the 3rd and 4th generation e-cigarettes, and have gained a leading position among ENDS. For example, Puff bar use among vapers in the United Kingdom reached 83% by 2023, 59% in Canada, and 67% in the United States (Hammond et al., 2024). Furthermore, recent epidemiological findings in Switzerland indicate that more than half of young people aged 14-25 have tried these products (Trovato-Abdellali et al., 2024). In France, 13% of middle and high school students reported having previously used puff bars (Josseran et al., 2023). There is virtually no scientific data on the use rates and potential health risks of these products, whose imports are banned in Türkiye.

CONCLUSION

While smoking is decreasing in the world, the use of new generation tobacco products is increasing in all societies. The reason for this is that the tobacco industry navigates every legal gap very well and creates a new target audience for itself. The real target of this public health problem is the youth. The rise in disposable e-cigarette use poses a public health threat and exacerbates the youth vaping epidemic, as most youth who use e-cigarettes report that they first started using a flavored variety. Starting e-cigarettes in adolescence or young adulthood increases the likelihood of later smoking. Flavors are the most important factor in the increase in ENDS use, especially disposable e-cigarettes. Banning the use of flavors or restricting the concentrations used can reduce e-cigarette use and potentially reduce exposure to toxic e-liquid components. The legal regulations introduced for cigarettes, especially flavors, need to be re-established or reviewed for e-cigarettes. It is necessary to increase social and scientific activities in all societies to inform the youth about e-cigarette use and its risks.

AUTHOR CONTRIBUTION STATEMENT

Concept and Design (İÇ), Literature Screening (PU), Interpretation (İÇ), Writing (İÇ, PU).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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