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Brief Report

Trends in US E-cigarette Sales and Prices by Nicotine Strength, Overall and by Product and Flavor Type, 2017–2022

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Abstract

Introduction: The e-cigarette market has expanded considerably in recent years, resulting in changes in availability and use of e-cigarettes with varying characteristics.

Aims and Methods: This study assessed trends in sales and prices of e-cigarettes by nicotine strength level, including by product type and flavor, during January 2017–March 2022. US e-cigarette retail sales data were licensed from IRI company. Nicotine strength was categorized as: <1%; 1% to <2%; 2% to <3%; 3% to <4%; 4% to <5%; ≥5%. E-cigarette flavors were categorized as tobacco, menthol, mint, or other flavors. Product type was categorized as prefilled cartridge devices, disposable devices, or e-liquid bottles. Trend analyses were performed using Joinpoint Regression.

Results: During January 2017–March 2022, the unit share of products containing ≥5% nicotine strength increased by 1486.3%, while the dollar share increased by 1345.5%. By March 2022, 80.9% of total unit sales were composed of products containing ≥5% nicotine strength. By flavor, the percentage of units sold with ≥5% nicotine strength was 61.3% of tobacco-flavor sales, 79.3% of menthol sales, 87.4% of mint sales, and 96.1% of other flavor sales. By product type, the percentage of units sold with ≥5% nicotine strength was 90.6% of disposable e-cigarette sales and 74.2% of prefilled cartridge sales. During January 2017–March 2022, the price of low-nicotine strength e-cigarettes increased, while the price of high-nicotine products either decreased or did not change.

Conclusions: Sales of high nicotine-strength e-cigarettes have dominated the US e-cigarette market. Limiting the nicotine strength of e-cigarettes could be considered as part of a comprehensive tobacco control strategy to reduce youth access to and use of these products.

Implications: The findings from this study indicate that previously reported increases in e-cigarette nicotine strength during 2013–2018 have continued through 2022. The US e-cigarette market sales continue to be dominated by relatively high-nicotine products. Strategies to address factors that make these products, particularly appealing to youth, including flavors and product innovations, are critical. Such strategies are important—as part of a comprehensive approach alongside other evidence-based population-level actions—to address youth e-cigarette use. Importantly, actions to reduce e-cigarette use among youth are not mutually exclusive from actions to maximize the potential benefits of e-cigarettes for increasing smoking cessation among adults.

Introduction

Since their introduction to the United States around 2007, the e-cigarette market has evolved considerably, resulting in changes in the availability and use of e-cigarettes with varying characteristics. One primary characteristic of e-cigarettes is their nicotine concentration, which is offered many strengths. Beginning in 2015 with the introduction of JUUL Labs, Inc., a growing number of e-cigarette manufacturers produced products with nicotine salts, rather than the freebase nicotine used in conventional tobacco products and earlier generation e-cigarettes.[1,2] Nicotine salts, which have a lower pH than freebase nicotine, allow particularly high levels of nicotine to be inhaled more easily and with less irritation to the throat. Nicotine salts might be appealing to adult smokers seeking e-cigarettes with greater nicotine delivery to facilitate the complete replacement of conventional cigarettes. However, a recent study found that sales increases in high-nicotine e-cigarettes were not associated with smoking cessation.[3] Furthermore, the appeal of such products could facilitate easier initiation and subsequent addiction among nicotine-naïve populations, including youth.[4]

E-cigarette product types have also diversified. Initial e-cigarettes resembled the same size and shape as conventional cigarettes, and were designed to be discarded when the charge or e-liquid was depleted (disposable e-cigarettes).[5] E-cigarettes with prefilled or refillable cartridges were subsequently introduced, followed by modifiable devices ("mods"), which allow users to customize the substances in the device. In 2015, the "pod mod" was introduced, which contained a refillable "pod" with e-liquid. More recently, nonrefillable disposable e-cigarettes have increased in popularity.

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The availability of flavored e-cigarettes has also changed over time. In February 2020, the Food and Drug Administration prohibited the sale of prefilled cartridges with flavors other than tobacco or menthol. More recently, sales of menthol-flavored prefilled cartridges and fruit-flavored disposable e-cigarettes have increased in the United States.[6]

Before 2013, most e-cigarette nicotine strength varied from 0.05% to 1.5%.[7] During 2013–2018, e-cigarettes with higher nicotine levels (>5%) increased considerably in unit share, and average nicotine strength rose from 2.1% to 4.3%.[8] This study assessed more recent e-cigarette units and dollar sales in the United States by nicotine strength, overall and by product and flavor type, during January 2017–March 2022. Trends in prices of e-cigarettes by nicotine strength were also assessed.

Methods

Data Source

E-cigarette retail sales data were licensed from Information Resources, Incorporated (IRI), for the period during January 26, 2017–March 20, 2022; data were included from the 48 continental states (excluding Alaska and Hawaii) and DC. The sales data included Universal Product Code sales from convenience stores, gas stations, grocery stores, drug stores/pharmacies, mass merchandiser outlets, retail chain stores, club stores, dollar stores, and military sales. Sales from the Internet and vape shops were not available. The data included weekly sales volume and dollar values and product features such as type, flavor, and nicotine strength. E-cigarette accessories and devices sold without e-liquids were excluded (4.0% of sales).

Measures

Nicotine strength information was available for 92.6% of the Universal Product Codes. Products with missing nicotine strength (7.4%) were searched online and identified. A small percentage (1.4%) of the missing nicotine products offered multiple nicotine levels; in these instances, average values were calculated. Nicotine strength label formats varied (either as percentages or mg/mL). All nicotine strengths were converted to percentages using the formula 1.0 mg/mL = 0.1%.[9] Nicotine strength level was categorized as follows: <1%; 1% to <2%; 2% to <3%; 3% to <4%; 4% to <5%; ≥5%. The majority (91%) of sales in the ≥5% category reflects sales from products containing 5% to <6%.

E-cigarette flavors were categorized as tobacco, menthol, mint, or other flavors (eg, fruits, candy, or sweet) using flavor descriptors in the dataset.[6] Ambiguous or concept flavors that could not be readily identified (eg, "fusion") (5.6% of sales) were searched online and categorized. Flavors that could not be classified accounted for <0.1% of sales. All e-cigarette products were categorized as prefilled cartridge devices, disposable devices, and e-liquids bottles.[6] Prefilled cartridges included cartridges or pods that come prefilled with e-liquids and used in reusable closed e-cigarette devices. Disposable devices included nonreusable e-cigarette devices that are not intended to be refilled with e-liquid after being depleted. E-liquid bottle sales (1%) were included in the analysis, but not presented separately.

Analysis

Dollar sales and unit sales were summed in 4-week periods (referred to as "month" henceforth); the total sample included 68 periods. To account for variations in product type, all units were standardized to reflect the most common package size for each product type. Following established methods,[6,10] a standardized unit was equal to: Five prefilled cartridges/pods; one disposable device; or one e-liquid bottle. Real weighted price per unit for each product (henceforth "price") was calculated as total monthly real dollar sales divided by total monthly standardized unit sales. The consumer price index for March 2022 was used to deflate dollar sales.

Trend analyses for total sales and price by nicotine strength, overall and by product and flavor type, were performed using Joinpoint Regression Program (version 4.9.0.0). The method of Joinpoint regression has been commonly used in the literature to detect points in time when trends changed significantly, quantify the direction, and magnitude of this change, and to assess its statistical significance.[6,11] Average monthly percent change (AMPC) with corresponding 95% confidence intervals were calculated. Statistical significance was defined as $p < .05$. Advarra, an independent institutional review board, determined that this research did not involve human participants and did not require institutional review board review.

Results

Total Sales by Nicotine Strength

During January 2017–March 2022, total monthly e-cigarette unit sales increased by 293.6%, from 5.7 million units to 23.3 million units (AMPC = 2.1, CI = 1.5–2.6) (Figure 1); total dollar sales increased by 528.7%, from $74.6 million to $469.0 million (AMPC = 2.8, CI = 1.9–3.7) (Supplementary Figure 1). During the same period, the percentage of sales with products containing ≥5% nicotine strength increased from 5.1% to 80.9% of total unit sales (AMPC = 4.2, CI = 3.7–4.6), and from 5.5% to 79.5% of total dollar sales (AMPC = 3.8, CI = 2.8–4.8). Products containing <1% nicotine strength (including zero-nicotine products) accounted for less than 0.1% of sales.

Flavors Sales by Nicotine Strength

Unit and dollar sales of all flavors increased in nicotine strength. During January 2017–March 2022, the proportion of e-cigarette unit sales containing ≥5% nicotine strength increased from 1.5% to 61.3% (AMPC = 6.0, CI = 5.0–7.0) for tobacco flavor; from 0.0% to 79.3% (AMPC = 14.9, CI = 11.3–18.7) for menthol; from 20.9% to 87.4% (AMPC = 2.2, CI = 1.3–3.1) for mint; and from 13.8% to 96.1% (AMPC = 2.9, CI = 2.2– 3.6) for other flavors (Supplementary Figure 2). During the same period, the proportion of e-cigarette dollar sales containing ≥5% nicotine strength increased from 2.1% to 61.4% (AMPC = 5.6, CI = 5.1–6.1) for tobacco; from 0.0% to 79.0% (AMPC = 16.9, CI = 12.8–21.1) for menthol; from 22.3% to 92.7% (AMPC = 2.2, CI = 1.4–3.1) for mint; and from 13.1% to 97.2% (AMPC = 2.9, CI = 2.4–3.4) for other flavors.

Product Type Sales by Nicotine Strength

During January 2017–March 2022, both disposable e-cigarettes and prefilled cartridges increased in nicotine strength with disposable devices experiencing the highest increase (Supplementary Figure 3). Among disposable e-cigarettes, the proportion of unit sales of products

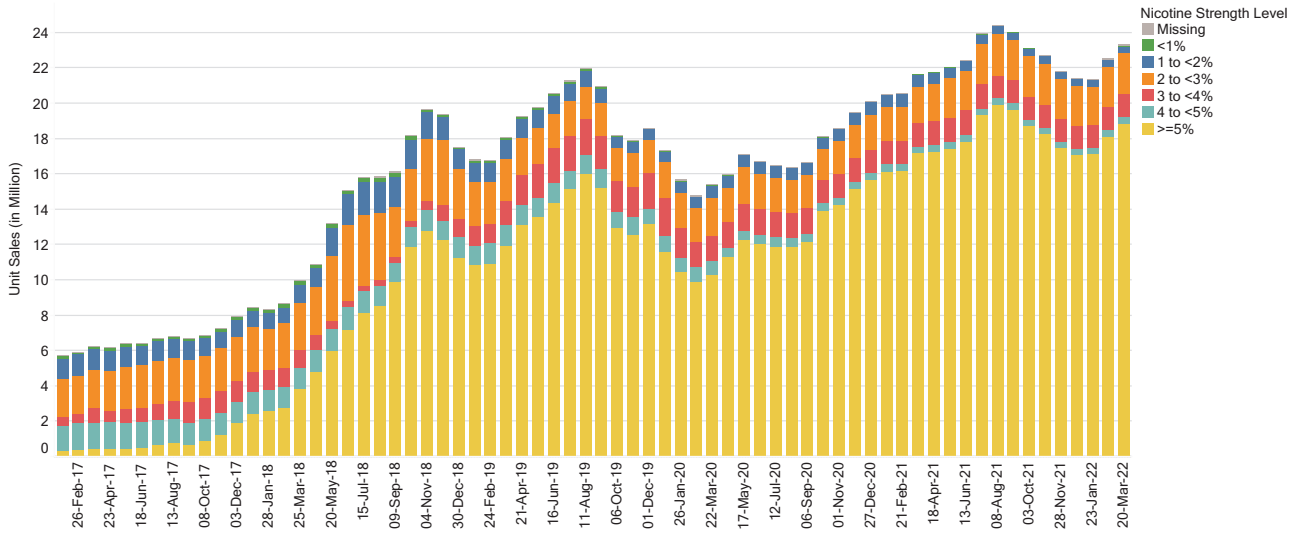

Figure 1. Total e-cigarette unit sales[a] by nicotine strength[b], United States[c], 2017–2022[d]. [a]Retail sales data were obtained from Information Resources, Inc (IRI) for convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores, and military sales; data from the Internet and vape shops were not collected. Unit sales were summed in 4-week periods. To account for variations in product type when summing unit sales, all units were standardized to reflect the most common package size: a standardized unit was equal to: Five prefilled cartridges/pods; one disposable device; or one e-liquid bottle. [b]Nicotine strength information was available in the data for 92.6% of the Universal Product Codes. Products with missing nicotine strength (7.4%) were searched online and identified. Nicotine strength level was categorized into five mutually exclusive categories: <1%; 1% to <2%; 2% to <3%; 3% to <4%; 4% to <5%; ≥5%. [c]Data were included from the 48 continental states (excluding Alaska and Hawaii) and Washington, DC. [d]Each bar in the figure represents a 4-week aggregate interval.

containing ≥5% nicotine strength increased from 0.0% to 90.6% (from 0.0% to 94.4% in dollar share) (AMPC = 18.3, CI = 16.8–19.8 for unit share; AMPC = 17.2, CI = 15.7–18.6 for dollar share). Among prefilled cartridges, the unit share of products containing ≥5% nicotine strength increased from 8.0% to 74.2% (from 6.9% to 73.0% in dollar share) (AMPC = 3.4, CI = 2.8–4.0 for unit share; AMPC = 3.6, CI = 3.2–4.0 for dollar share).

Average Price by Nicotine Strength

During January 2017–March 2022, the price of products with low nicotine strength increased, while the price of products with high nicotine strength has either decreased or did not change (Figure 2). Specifically, the price of products containing 1% to <2% nicotine strength increased by 180.2% from $10.4 to $29.2 (AMPC = 1.5, CI = 1.1–2.0); the price of 2% to <3% nicotine strength increased by 57.1% from $13.5 to $21.3 (AMPC = 0.7, CI = 0.1–1.4); and the price of 3% to <4% nicotine strength increased by 30.6% from $17.8 to $23.3 (AMPC = 0.4, CI = 0.1–0.8). In contrast, the price of products containing 4% to <5% nicotine strength decreased by 35.8% from $20.0 to $12.8 (AMPC = −0.6, CI = −0.9 to −0.3). The price of products containing ≥5% nicotine strength increased by 20.7% from $16.4 to $19.8, but this increase was not statistically significant.

Discussion

During January 2017–March 2022, e-cigarettes containing ≥5% nicotine strength accounted for increasing percentages of e-cigarette sales both in dollars and units; unit share increased by nearly 15 000%, while dollar share increased by more than 1300%. By March 2022, the majority of total unit (80.9%) and dollar (79.5%) sales were for products containing ≥5% nicotine strength. Furthermore, in March 2022, 61.3% of tobacco sales, 79.3% of menthol sales, 87.4% of mint sales, and 96.1% of other flavor sales were for products containing ≥5% nicotine strength. Disposable e-cigarettes and prefilled cartridges all increased in nicotine strength, and by March 2022, most disposable e-cigarettes and prefilled cartridges sold had nicotine strength ≥5%.

High nicotine-strength products represent a significant public health concern for young people; for nicotine-naïve youth who experiment with high nicotine-strength e-cigarettes, the potential for addiction may be increased. For adult cigarette smokers, e-cigarettes with higher nicotine concentration e-cigarettes might be more likely to adequately replace the amount of nicotine delivered compared to lower nicotine strength e-cigarettes, potentially increasing the likelihood of transitioning to exclusive e-cigarette use. However, no e-cigarette is currently approved by the Food and Drug Administration as a smoking cessation aid. There are currently no limits on nicotine concentrations in e-cigarettes in the United States. In contrast, many regions, including the European Union, Canada, United Kingdom, China, and the Russian Federation, limit maximum nicotine strength to 20 mg/mL%.[12] Many of these regions also limit the maximum volume of refill liquids to 10 mL, an option that could be considered as part of a comprehensive nicotine standard policy in the United States.[13] A nicotine standard could reduce the addictiveness of these products, particularly to populations like youth.

The unit price of e-cigarettes with nicotine strength <4% increased, while the price of products with higher nicotine strength either decreased (4% to <5% nicotine strength) or did not change (≥5% nicotine strength). Differential pricing could potentially be used to incentivize adult smokers to completely transition from combustible products to less hazardous noncombustible products, including e-cigarettes. However, lower prices of high-nicotine e-cigarettes can also

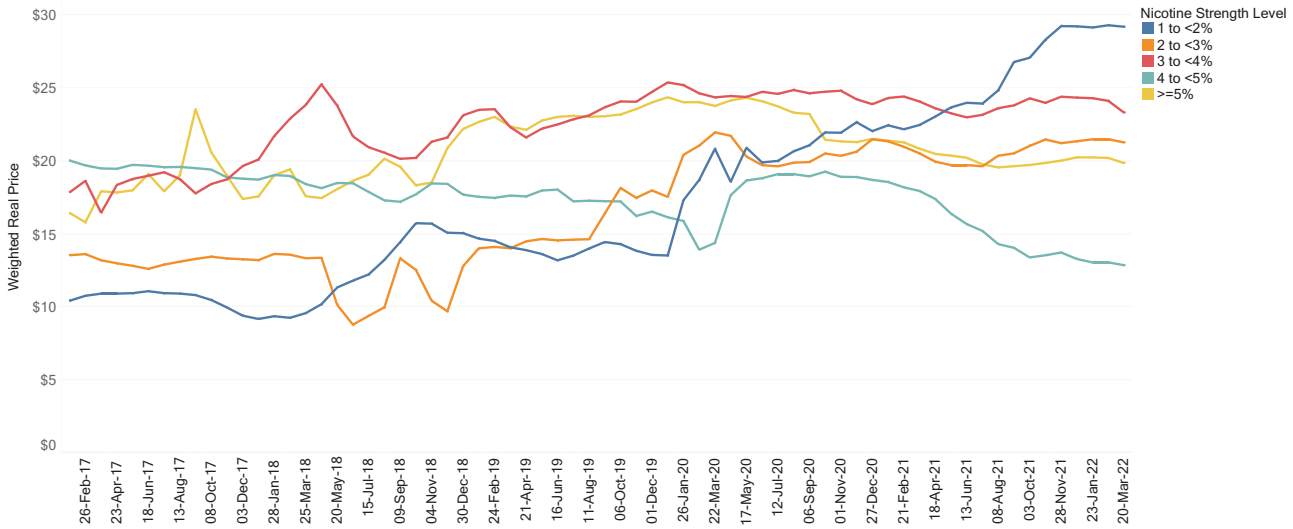

Figure 2. Weighted average inflation-adjusted price[a] by nicotine strength[b], United States[c], 2017–2022[d].[a]Retail sales data were obtained from Information Resources, Inc (IRI) for convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores, and military sales; data from the Internet and vape shops were not collected. Real weighted price per unit for each product was calculated as total inflation-adjusted dollar sales divided by total standardized unit sales. The consumer price index for March 2022 was used to calculate real (inflation-adjusted) dollar sales.[b]Nicotine strength information was available in the data for 92.6% of the Universal Product Codes. Products with missing nicotine strength (7.4%) were searched online and identified. Nicotine strength level was categorized into five mutually exclusive categories: <1%; 1% to <2%; 2% to <3%; 3% to <4%; 4% to <5%; ≥5%.[c]Data were included from the 48 continental states (excluding Alaska and Hawaii) and Washington, DC.

facilitate increased uptake and use of these products, including among youth, who have less discretionary income and are more sensitive to tobacco product price compared to adults.[14] Increasing tobacco product price, most notably conventional cigarettes, is inversely associated with consumption, particularly among youth[15]; however, research on the relationship between e-cigarette price and youth use is limited. A recent study found that a 10% increase in price leads to as much as a 24% reduction in e-cigarette demand among youth tobacco product users, and as much as a 45% reduction among those not currently using tobacco products.[16] In contrast, another study found no relationship between rechargeable e-cigarette prices and past 30-day e-cigarette use among youth.[17] The potential association between e-cigarette price and use should be further examined, especially by nicotine strength.

This study is subject to at least four limitations. First, sales from the Internet and vape shops are not included; approximately 20% of e-cigarette sales occur online.[18] Second, sales data comes from retail scanners; no information about purchaser characteristics, including age, or actual product use can be ascertained. Third, the concentration of nicotine in an e-cigarette product may not reflect the concentration of nicotine absorbed by the user, which is dependent on several different factors.[19] Finally, nicotine strength labeled on packaging may not accurately reflect actual measurements.[20]

These findings indicate that previously reported increases in e-cigarette nicotine strength during 2013–2018 have continued through 2022, and US e-cigarette market sales continue to be dominated by relatively high-nicotine products. Strategies to address factors that make these products, particularly appealing to youth, including flavors and product innovations, are critical. Importantly, actions to reduce e-cigarette use among youth are not mutually exclusive from actions to maximize the potential benefits of e-cigarettes for increasing smoking cessation among adults.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

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Declaration of Interests

Ali reported receiving grants from Bloomberg Philanthropies to the CDC Foundation during the conduct of the study. Seaman reported receiving grants from Bloomberg Philanthropies during the conduct of the study. Crane reported receiving grants from Bloomberg Philanthropies during the conduct of the study. Schillo reported receiving financial support from a CDC Foundation subcontract through Bloomberg Philanthropies during the conduct of the study. No other disclosures were reported.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention.

Data Availability

Data were purchased from Information Resources, Inc (IRI, www.iriworldwide.com), through a restricted-use data

contract and thus cannot be shared with the public or any third parties. Interested parties may contact IRI directly to determine data purchasing prices and options.

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