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Trends in unit sales of cooling flavoured e-cigarettes, USA, 2017–2021

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Received 10 March 2022

Accepted 24 June 2022

Published Online First

15 July 2022

ABSTRACT

Objective Flavours that produce a cooling sensation, such as menthol, enhance the appeal of e-cigarettes among youth; but not all e-cigarettes that produce cooling sensations are labelled as menthol. This study assessed trends in unit sales of cooling flavoured e-cigarettes in the USA.

Design E-cigarette retail sales during 26 January 2017 to 28 November 2021 were licensed from Information Resources, Inc, which records brick-and-mortar retail scanner sales but not online or vape shop sales. Cooling flavours were identified using six descriptors: menthol, ice, cool, chill, freeze or frost; ambiguous flavours were verified using online searches. Cooling flavours were categorised by characterising flavour (menthol, mint, other) and product type (prefilled cartridges, disposables, e-liquids). Joinpoint regression was used to assess sales and price trends.

Results During January 2017 to November 2021, unit sales of cooling flavoured e-cigarettes increased by 693.0% (1.5 to 12.0 million units); the percentage of these sales from total sales increased from 26.4% to 54.9%. Among cooling flavours, percentage of menthol sales decreased from 94.5% to 73.0% ($p<0.001$). Among menthol cooling flavours, percentage of prefilled cartridges increased from 67.2% to 96.6% ($p<0.001$); among non-menthol cooling flavours, percentage of disposable e-cigarettes increased from 5.2% to 99.2% ($p<0.001$). There were no significant price differences between cooling and non-cooling flavoured disposable e-cigarettes.

Conclusion The percentage of cooling flavoured e-cigarette sales from total sales doubled during 2017–2021, and sales of non-menthol cooling disposable e-cigarettes experienced the highest percentage increase. Cooling flavoured e-cigarettes are important to consider when developing strategies to address flavoured e-cigarette use among youth.

INTRODUCTION

Since electronic cigarettes (e-cigarettes) first entered the US marketplace around 2007,¹ the number of products and device types available has grown rapidly.² The first e-cigarettes to enter the marketplace resembled the same size and shape as combustible cigarettes. Subsequent generations of e-cigarettes were larger in size and included those that allowed users to refill the product with an e-liquid of their preference, either directly into the device or using a prefilled cartridge or pod.¹ More recently, disposable e-cigarettes that are single use products with prefilled e-liquid and a precharged

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Use of cooling flavoured e-cigarettes is associated with greater nicotine dependence and combustible tobacco smoking among youth and young adults

WHAT THIS STUDY ADDS

- ⇒ This is the first paper to assess the market share and sales trends of cooling flavoured e-cigarettes in the USA.
- ⇒ During January 2017 to November 2021, percentage of cooling flavoured e-cigarette sales from total sales doubled from 26.4% to 54.9%.
- ⇒ While menthol is still the predominant cooling flavour, sales of non-menthol cooling disposable e-cigarettes experienced the highest percentage increase.
- ⇒ The price of a cooling disposable e-cigarette was not statistically different from a non-cooling disposable e-cigarette, suggesting that the increase in cooling disposable e-cigarette sales was likely driven by user taste preferences for these flavours.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ As an increasing number of policies are implemented that address menthol-flavoured tobacco products, it is important to consider other flavours that might have the same impact as menthol on individual users, but are not currently designated as 'characterizing flavors' under existing regulatory standards at the national, state or local levels.

battery have increased in popularity, particularly among young people.³

As the e-cigarette product marketplace has evolved, so has the availability of different flavours. Flavours increase the appeal of tobacco products, including e-cigarettes, among youth and young adults.^{3 4} However, flavours are multidimensional in that they can increase appeal among people who use e-cigarettes in multiple ways, including through both taste and chemesthesis, or the sensation that arises when chemical compounds activate senses such as temperature. For example, menthol is a flavour additive that creates a cooling sensation in the mouth and throat, which reduces the harshness of tobacco product use among users; this can particularly increase appeal of e-cigarettes



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To cite: Ali FRM, Seaman EL, Diaz MC, et al. *Tob Control* 2024;**33**:147–153.

among nicotine-naïve populations such as youth.^{4,5} People who use e-cigarettes report higher cravings after using a combined menthol and fruit flavour product than using menthol alone.⁶ However, cooling sensations similar to those produced by menthol can also be produced through other flavour additives, including menthone and eucalyptol.⁷ Many e-cigarettes that include additives to create a cooling sensation are labelled with descriptors such as 'ice', 'cool', 'chill', 'frost' and 'freeze'.⁵ Some of these products are also labelled with a combination of a characterising flavour (eg, fruity/sweet) and a cooling sensation (eg, 'blueberry ice' or 'melon ice').

Given the role flavours play in increasing appeal of tobacco products among young people,¹ an increasing number of policies have been implemented at the national, state and local levels that restrict the availability of flavoured products. For example, on 6 February 2020, the US Food and Drug Administration (FDA) began enforcing a ban on the sale of flavoured e-cigarettes, excluding tobacco and menthol flavours.⁸ The policy applied to certain unauthorised flavoured cartridge-based e-cigarette products that appeal to youth, but did not apply to disposable e-cigarettes or tank-based e-cigarette devices. At the state level, Massachusetts, New York, Rhode Island and Washington have also adopted policies, some of which were temporary in response to the 2019 e-cigarette or vaping use-associated lung injury (EVALI) outbreak, to restrict the sale of non-tobacco-flavoured e-cigarettes; including menthol flavour.⁹ These policies have typically applied to 'characterizing flavors', which are defined as flavours with a distinguishable taste or aroma (eg, chocolate, vanilla, fruit), excluding tobacco flavour. However, the definition of a characterising flavour generally accounts for taste, but not necessarily all the dimensions of flavour (ie, sensory experience). Therefore, policies based on characterising flavour might not cover constituents that provide a cooling sensory experience (eg, similar to menthol) that can increase appeal, but are not necessarily the characterising flavour.¹⁰

Little is currently known about use of cooling flavoured e-cigarettes. A 2019 survey of Connecticut high school students found that approximately half (51.6%) of current e-cigarette users reported using cooling flavours, with the odds of using cooling flavours being associated with greater frequency of use and the use of nicotine-containing products compared with non-cooling-flavoured products.⁴ Similarly, findings from a survey of young adults in California found that nearly half of current e-cigarette users reported using ice flavours most often.⁵ The same study also found that ice flavour users had increased odds of concurrent combustible tobacco product use, increased frequency and intensity of e-cigarette use, use of disposable e-cigarettes and greater dependence symptoms when compared with users of other flavours.⁵ These findings align with a study that found young adults who use disposable e-cigarettes with ice flavours reported using the products on more days per month than their peers who use fruit or sweet-flavoured products.¹¹

To date, no published research has assessed the market share or sales trends of cooling flavoured e-cigarettes in the USA; such data could help document the extent of these products in the marketplace, and help inform public health policy and practice. To address this gap, this study assessed cooling flavoured e-cigarette sales in the USA, by major characterising flavour category and product type. Additionally, unit prices for cooling flavoured e-cigarettes were compared with non-cooling flavoured e-cigarettes.

METHODS

Data sources

US retail sales data were licensed from Information Resources, Inc (IRI) for the period during 26 January 2017 to 28 November 2021; data were provided for total US sales, which reflected sales from the 48 continental states (excluding Alaska and Hawaii). The data included universal product code sales from convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, retail chain stores, club stores, dollar stores and military sales. Sales from the internet and tobacco-specialty stores were not available from IRI. E-cigarette accessories and devices sold without e-liquids were excluded from the analysis (11.5% of sales). Sales were summed in 4-week periods (referred to as 'month' henceforth); the total sample included 64 four-week periods.

Measures

Flavours that provide cooling sensation were identified using the following six descriptors: menthol, ice, cool, chill, freeze or frost (eg, watermelon ice, frosted apple, cool mint, menthol). Cooling flavours were further categorised based on major characterising flavours into three categories: menthol, mint and all other flavours. Menthol cooling flavours included those with menthol as the only characterising flavour (eg, chill menthol, cool menthol, menthol). Mint cooling flavours included cooling flavours with mint as the only characterising flavour (eg, ice mint, mint freeze, glacier mint, cool mint). Other cooling flavours included cooling flavours with other characterising flavours (eg, banana ice, cool ice, ice, peach freeze, frosted apple, tobacco chill, mango menthol). Ambiguous or concept flavours that could not be readily identified (eg, 'fusion') (5.6% of sales) were searched online and categorised based on their description. Flavours that could not be classified accounted for less than 0.1% of sales. Hardware sold without e-liquid were excluded from the analysis.

In addition to flavours, all cooling-flavoured products were categorised into three product types: prefilled cartridge devices, disposable devices and e-liquid bottles.¹²⁻¹⁴ Prefilled cartridges included tanks, cartridges and pods used in rechargeable and reusable e-cigarette device. Starter kits sold with prefilled cartridges were included in this categorisation; those that were sold without prefilled cartridges were considered hardware, and therefore excluded from the analysis. Starter kits with prefilled cartridges accounted for 3.1% and 3.4% of prefilled cartridge sales in years 2020 and 2021, respectively. Sensitivity analysis excluding starter kits yielded similar results.

Disposable devices included non-rechargeable and non-reusable e-cigarette devices that are not intended to be refilled with e-liquid after being depleted. E-liquid bottles accounted for less than 1% of total sales; thus, these sales were included in the overall analysis of sales, but not presented separately in the results.

Real weighted price per unit for each product (referred to as 'price' henceforth) was calculated as total monthly real dollar sales divided by total monthly standardised unit sales. Consumer price index for January 2020 was used to adjust for inflation. To account for variations in product type when summing unit sales, units were standardised to reflect the most common package size for each product type. Following previous studies,¹²⁻¹⁴ a standardised unit was equal to: five prefilled cartridges/pods; one disposable device; one starter kit with a prefilled cartridge; or one e-liquid bottle.

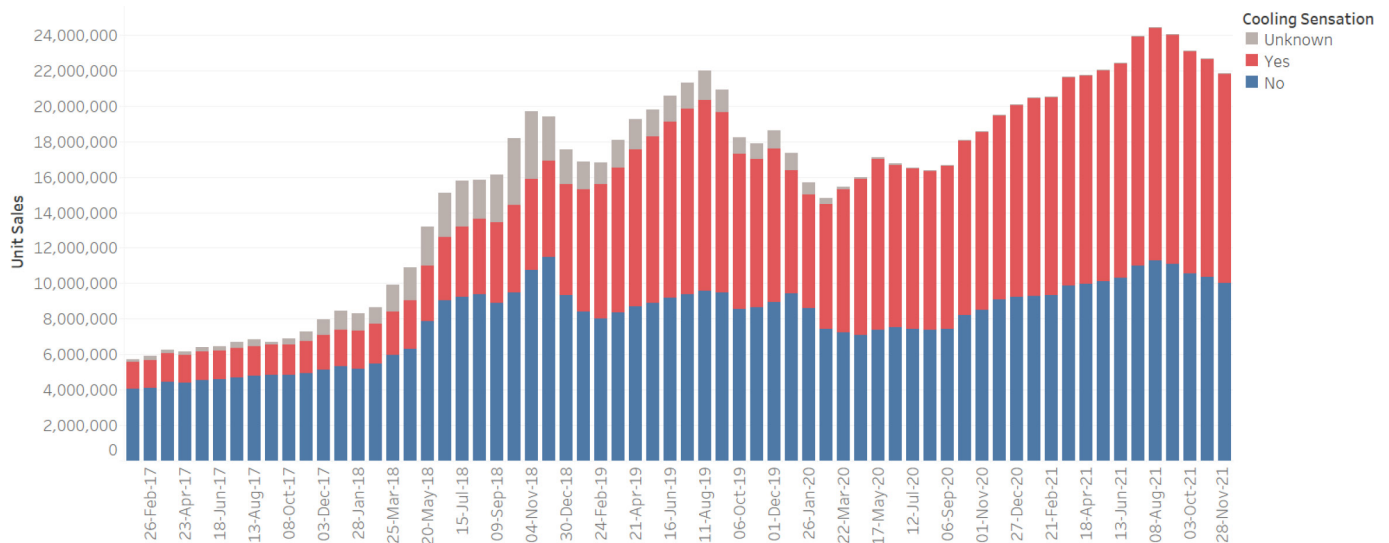


Figure 1 E-cigarette unit sales^a by cooling flavour status^b, total US sales, 2017–2021^c. ^aRetail sales data were obtained from Information Resources, Inc (IRI) for convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores and military sales; data from the internet and vape shops were not collected. Actual unit sales were presented in the figure. ^bCooling flavours were identified using the following six flavour descriptors: menthol, ice, cool, chill, freeze or frost (eg, watermelon ice, peach freeze, frosted apple, cool mint, menthol). ^cEach bar in the figure represents a 4-week aggregate interval.

Statistical analysis

Trend analyses were performed using Joinpoint regression program (V.4.9.0.0) for total unit sales, the proportion of sales by cooling flavour status, the proportion of cooling flavoured sales by major characterising flavours and product type. Furthermore, trends in unit price by product type were analysed for cooling versus non-cooling flavoured unit sales. Stata program (V.17) was used to test for differences in price trends by product type.

Joinpoint regression was used to detect points in time when total sales trends changed, to quantify the direction and magnitude of this change and to assess its statistical significance. Monthly per cent change (MPC) with corresponding 95% CIs was calculated. Time segments with the same direction, but different magnitude of change, were combined, and average monthly per cent change (AMPC) was calculated for the overall period, along with a p value, using Joinpoint regression program.^{15 16} To further simplify the presentation of results, time points detected by the total sales analysis were used in subsequent analyses, by flavour and products type, to test whether sales trends of these categories varied significantly at these time points. Statistical significance was defined as $p < 0.05$.

RESULTS

Trends in total e-cigarette unit sales, overall and by cooling flavour status

During January 2017 to November 2021, total unit sales increased by 281.7% ($p < 0.05$) from 5.7 to 21.9 million units per month (AMPC=2.2; 95% CI 1.6 to 2.7); however, sales fluctuated during this period (figure 1). The Joinpoint regression analysis identified three periods when trends changed significantly (ie, joinpoints). The joinpoints were January 2017 to August 2019, August 2019 to February 2020, and February 2020 to November 2021. During January 2017 to August 2019, sales increased by 284.0% from 5.7 to 22.0 million units per month (AMPC=4.1; 95% CI 3.3 to 4.9) ($p < 0.001$). During August 2019 to February 2020, sales decreased by 32.7% from 22.0 to 14.8 million units per period (MPC=−5.0; 95% CI −7.1 to

−2.9) ($p < 0.001$). During February 2020 to November 2021, sales increased by 47.7% from 14.8 to 21.9 million units per month (MPC=1.7; 95% CI 0.9 to 2.5) ($p < 0.001$).

Among total e-cigarette unit sales in November 2021, the proportion of cooling flavoured e-cigarette sales was 54.9% (vs 45.1% non-cooling flavoured sales). During January 2017 to November 2021, sales of cooling flavoured e-cigarettes increased by 693.0% (from 1.5 to 12.0 million units) (AMPC=3.4, $p < 0.001$); unit share increased from 26.4% to 54.9%. Fluctuations were also observed within this period. During January 2017 to August 2019, sales of cooling flavoured e-cigarettes increased by 618.7% (from 1.5 to 10.9 million) (AMPC=6.1, $p < 0.001$); unit share increased from 26.4% to 49.5%. During August 2019 to February 2020, sales decreased by 34.4% (from 10.9 to 7.1 million) (MPC=−5.1, $p < 0.001$); unit share decreased from 49.5% to 48.3%. During February 2020 to November 2021, sales increased by 68.1% (from 7.1 to 12.0 million) (AMPC=2.2, $p < 0.001$); unit share increased from 48.3% to 54.9%.

Trends in cooling flavoured e-cigarette sales by characterising flavour and product type

Among cooling flavoured e-cigarette sales in November 2021, menthol accounted for 73.0%, mint accounted for 4.9% and other flavours (eg, tobacco, fruits, candy/sweet, etc) accounted for 22.1% (figure 2). During January 2017 to November 2021, sales of menthol cooling flavours increased by 519.5% (from 1.4 to 8.8 million); unit share however decreased from 93.5% to 73.0% (AMPC=−0.5, $p < 0.001$). During the same period, sales of cooling flavours other than menthol and mint increased by 12959.6% (from 20.3 thousand to 2.7 million), and unit share increased as well from 1.3% to 22.1% (AMPC=4.7, $p < 0.001$). There was no significant change in the unit share of mint cooling flavours at the end of the study period compared with the beginning of the period. However, fluctuations were observed during the study period for all the three flavour categories.

During January 2017 to August 2019, unit share of menthol cooling flavours decreased from 93.5% to 22.9% (AMPC=−4.2,

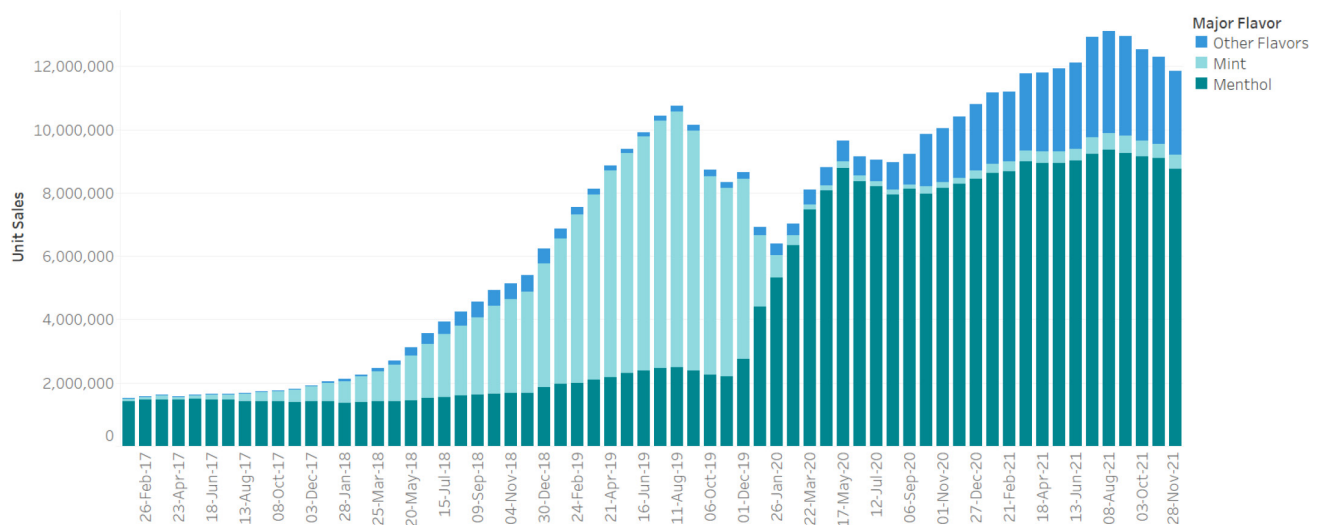


Figure 2 Cooling flavoured e-cigarette sales^a by major characterising flavours^b, total US sales, 2017–2021^c. ^aRetail sales data were obtained from Information Resources, Inc (IRI) for convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores and military sales; data from the internet and vape shops were not collected. Actual unit sales were presented in the figure. Cooling flavours were identified using the following six flavour descriptors: menthol, ice, cool, chill, freeze or frost (eg, watermelon ice, peach freeze, frosted apple, cool mint, menthol). ^bMenthol cooling flavours included those with menthol as the only characterising flavour (eg, chill menthol, cool menthol, menthol). Mint cooling flavours included cooling flavours with mint as the only characterising flavour (eg, ice mint, mint freeze, glacier mint). Other cooling flavours included cooling flavour with other characterising flavours besides only menthol and mint (eg, banana ice, tobacco chill, mango menthol, cool ice). ^cEach bar in the figure represents a 4-week aggregate interval.

$p < 0.001$); while mint's share increased from 5.2% to 75.3% (AMPC=8.6, $p < 0.001$). Both mint and menthol dominated (98.3%) the cooling flavoured e-cigarette market during this time period. During August 2019 to February 2020, the share of menthol increased from 22.9% to 88.7% (AMPC=20.9, $p < 0.001$), while share of mint decreased from 75.3% to 5.9% (AMPC=-29.2, $p < 0.001$). The share of all other cooling flavours increased from 1.7% to 5.4% (AMPC=14.4, $p < 0.001$). During February 2020 to November 2021, both the shares of menthol (from 88.7% to 73.0%; AMPC=-1.1, $p < 0.001$) and mint (5.9% to 4.9%; AMPC=-1.0, $p < 0.001$) decreased. In contrast, unit share of other cooling flavours increased from 5.4% to 22.1% (AMPC=7.4, $p < 0.001$).

During January 2017 to November 2021, prefilled cartridges were the predominated product type for the menthol cooling flavour market; disposable e-cigarettes were the predominate product type for the non-menthol cooling flavour market (figure 3). Among menthol cooling flavours during January 2017 to November 2021, sales of prefilled cartridges increased by 790.5% (from 1.0 to 8.5 million) and its unit share increased from 67.2% to 96.6% (AMPC=0.6, $p < 0.001$); sales of disposable e-cigarettes decreased by 25.3% (from 0.4 to 0.3 million) and its unit share decreased from 28.5% to 3.4% (AMPC=-3.4, $p < 0.001$).

Among mint cooling flavours during January 2017 to November 2021, sales of disposable e-cigarettes increased by 13603.9% (from 4.2 to 578.9 thousand) and its unit share increased from 5.4% to 99.4% (AMPC=4.6, $p < 0.001$); sales of prefilled cartridges decreased by 96.4% (from 73.7 to 2.6 thousand) and its unit share decreased from 94.4% to 0.5% (AMPC=-7.8, $p < 0.001$). Among other cooling flavours during January 2017 to November 2021, sales of disposable e-cigarettes increased by 290709.4% (from 0.9 thousand to 2.6 million) and its unit share increased from 4.5% to 99.2% (AMPC=5.1, $p < 0.001$); sales of prefilled cartridges increased by 581.6% (from 3.2 to 22.0 thousand) while its unit share decreased from

15.9% to 0.8% (AMPC=-5.0, $p < 0.001$) (e-liquid accounted for 79.6% (16.2 thousand units) of other cooling flavour sales in January 2017).

Trends in average prices for cooling versus non-cooling flavoured e-cigarettes

For disposable e-cigarettes, the unit price of cooling flavoured products was not statistically different from the unit price for those that did not provide cooling sensation ($p = 0.97$) (figure 4). As of November 2021, the price of a cooling flavoured disposable e-cigarette was \$13.5, while a non-cooling flavour disposable e-cigarette was \$13.1. During January 2017 to November 2021, the price of a cooling disposable e-cigarette increased from \$6.6 to \$13.5 (102.5%); the price of a non-cooling disposable e-cigarette increased from \$6.8 to \$13.1 (93.2%). However, these trends were not statistically different ($p = 0.27$).

For prefilled cartridges, the unit price of cooling flavoured products was significantly higher than the price of products that were not cooling flavoured ($p < 0.001$). As of November 2021, the price of five prefilled cartridges that provided cooling sensation was \$20.9, while the price for the same number of cartridges that were not cooling flavoured was \$20.7. During the study period, the price of five prefilled cartridges that were cooling flavoured increased from \$17.9 to \$20.9 (16.7%). The price of the same number of cartridges that were not cooling flavoured increased from \$18.5 to \$20.7 (11.6%). These trends were statistically different ($p < 0.001$).

DISCUSSION

Unit sales of cooling flavoured e-cigarettes increased seven-fold during 2017–2021. By November 2021, cooling flavours comprised over half the share of total US e-cigarette sales. While menthol is still the predominant cooling flavour, the greatest percentage increase in these sales during the study period occurred in disposable e-cigarettes in the 'other' cooling flavour

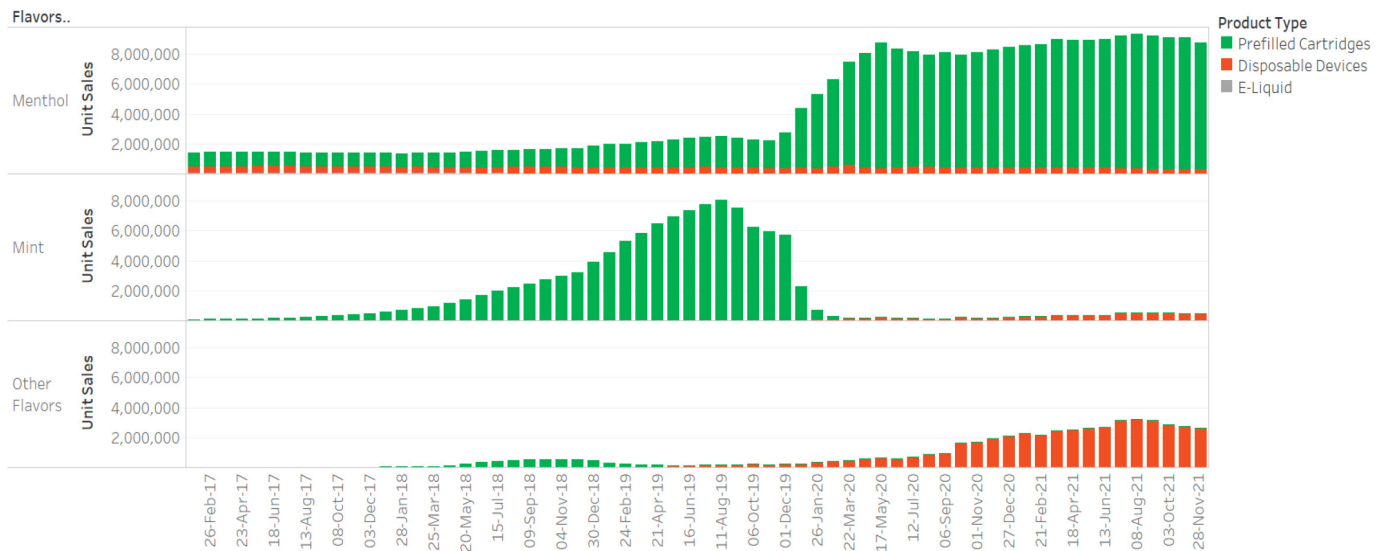


Figure 3 Trends in cooling flavoured e-cigarette sales^a by flavours and product type^b, total US sales, 2017–2021^c. ^aRetail sales data were obtained from Information Resources, Inc (IRI) for convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores and military sales; data from the internet and vape shops were not collected. Actual unit sales were presented in the figure. Cooling flavours were identified using the following six flavour descriptors: menthol, ice, cool, chill, freeze or frost (eg, watermelon ice, peach freeze, frosted apple, cool mint, menthol). ^bPrefilled cartridges included tanks, cartridges and pods used in rechargeable and reusable e-cigarette device. Starter kits sold with prefilled cartridges were included in this categorisation. Disposable devices included non-rechargeable and non-reusable e-cigarette devices that are not intended to be refilled with e-liquid after being depleted. ^cEach bar in the figure represents a 4-week aggregate interval.

category, which includes cooling flavours such as banana ice, peach freeze and frosted apple. The price of a cooling disposable e-cigarette was not statistically different from a non-cooling disposable e-cigarette, suggesting that the increase in cooling disposable e-cigarette sales was likely driven by user taste preferences for these flavours. These findings are consistent with previous research documenting an increase in disposable sales

and use in recent years,^{3 12} including following the US FDA's January 2020 prohibition of flavoured cartridge-based e-cigarette products,⁸ and indicate a growing market for non-menthol-flavoured products in the USA that provide a similar cooling sensation to mentholated e-cigarettes.¹⁷

The increase in disposable products and fruit cooling flavoured products is a public health concern because these products are

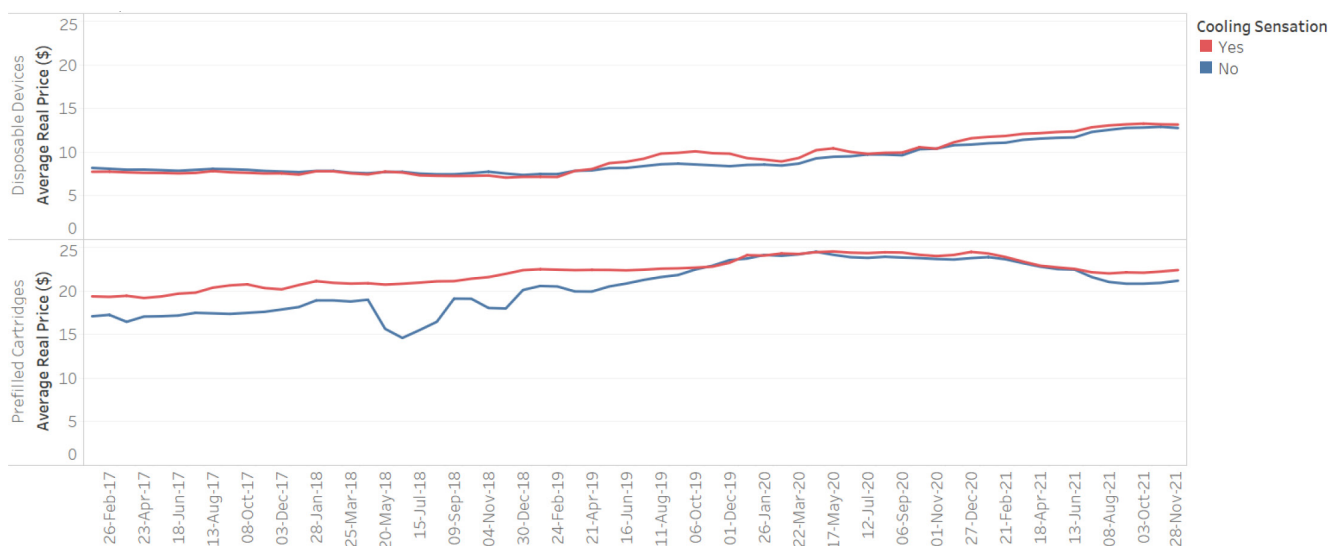


Figure 4 Trends in unit prices^a for cooling^b versus non-cooling flavours by product type^c, total US sales, 2017–2021^d. ^aRetail sales data were obtained from Information Resources, Inc (IRI) for convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores and military sales; data from the internet and vape shops were not collected. Weighted average real price per unit for each product was calculated as total monthly real dollar sales (after adjusting for inflation) divided by total monthly standardised unit sales. Consumer price index for January 2020 was used to adjust dollar sales. ^bCooling flavours were identified using the following six flavour descriptors: menthol, ice, cool, chill, freeze or frost (eg, watermelon ice, peach freeze, frosted apple, cool mint, menthol). ^cPrefilled cartridges included tanks, cartridges and pods used in rechargeable and reusable e-cigarette device. Starter kits sold with prefilled cartridges were included in this categorisation. Disposable devices included non-rechargeable and non-reusable e-cigarette devices that are not intended to be refilled with e-liquid after being depleted. ^dEach bar in the figure represents a 4-week aggregate interval.

used prominently by youth; however, our data do not allow us to interpret the age of purchaser. In 2021, 84.7% of youth who currently used e-cigarettes in the USA used flavoured e-cigarettes, of which fruit was the predominant flavour.¹⁸ Although it is unknown what per cent of these fruit-flavoured products contained cooling flavours, two prior studies found that nearly half of youth who currently use e-cigarettes reported using cooling flavours most often.^{4,5} Cooling flavours have been associated with greater frequency and intensity of using nicotine-containing e-cigarettes, increased use of disposable devices and increases in dependence.⁵ Additionally, emerging research suggests that cool or ice flavoured e-cigarettes may have differential health effects, including higher likelihood of generating reactive oxygen species, which can promote oxidative stress-induced damage with pulmonary cells.¹⁹

This research further documents the rapidly evolving nature of the US e-cigarette marketplace, including in response to regulation and product preferences, as well as public health outbreaks, including EVALI and COVID-19.^{12,20,21} In early 2020, the US FDA prohibited flavoured cartridge-based e-cigarette products. This did not include tobacco-flavoured and menthol-flavoured products, as well as open systems and all flavoured disposable e-cigarettes.⁸ Several jurisdictions have also implemented strategies to address flavoured tobacco product sales, including e-cigarettes; as of December 2021, seven states, over 300 localities and three Native American tribes have placed some type of restriction on flavoured tobacco products.²² For example, during late September 2019, Massachusetts implemented a policy that restricted the sale of all e-cigarettes in stores and online, which was narrowed to restrict the sale of non-tobacco-flavoured e-cigarettes, including menthol, as of December 2019. Similar restrictions on non-tobacco-flavoured e-cigarettes have also been implemented in New York (May 2020), Rhode Island (October 2019 and made permanent in March 2020) and Washington (October 2019 and lasted 120 days). Existing research shows that state-wide restrictions on the sale of flavoured e-cigarettes in these states were associated with a significant reduction in total e-cigarette sales.²³ This reduction was mostly driven by non-tobacco-flavoured e-cigarette sales, which were partially compensated by an increase in tobacco-flavoured e-cigarette sales. However, the finding of an overall decline indicates that not all people who purchased non-tobacco-flavoured e-cigarettes switched to purchasing tobacco-flavoured e-cigarettes following policy implementation, suggesting limited e-cigarette product substitution.²³

As an increasing number of policies addressing flavoured tobacco products are implemented, it is important for national, state and local decision makers to consider the proliferation of products not covered under existing policies, as well as the health equity impact of these policies, including coverage among populations disproportionately affected by tobacco use²⁴; in the past, sales of products exempted from policies (eg, menthol e-cigarettes and flavoured disposable products) have increased rapidly following policy implementation.^{12,21} Similarly, flavours that might provide the same cooling sensation as menthol on individual users, but are not currently designated as characterising flavours, might not be covered by existing policies at the national, state or local levels. This is especially important given that an increasing number of e-cigarette brands have begun labelling products with 'concept' flavour names.²⁵

Strengths and limitations

To our knowledge, this is the first study to provide trend analysis of retail sales of cooling sensation flavoured products. The study also allowed for a way to monitor dynamic changes in the US e-cigarette market occurring at the monthly level, which would not otherwise be captured by self-reported surveys of e-cigarette use conducted once annually.

Nonetheless, this study is subject to at least five limitations. First, retail sales do not provide information on purchaser age, so it is not possible to distinguish whether sales were made by youth, young adults or adults, or whether persons who made the purchases actually used the products. However, the sales reflected in this study would have likely included products obtained directly or indirectly by youth; for example, three-quarters of youth who reported using JUUL e-cigarettes, a market leader through 2020, reported purchasing these products from a retail store.²⁶ Second, these data do not include sales from independent vape shops or online sales. Prior estimates indicate that in 2019, approximately one-third or less of e-cigarette sales were online.^{27,28} Third, ambiguous flavours were back coded using online searches, which might have resulted in misclassification; however, the extent of back coding was minimal (5.6%). Furthermore, flavours with cooling sensation were identified based on online search and flavour descriptors, which might not accurately capture product ingredients. Fourth, unit sales were standardised to reflect the most common package count, regardless of e-liquid volume or nicotine strength, which may vary across and within product types. Finally, the study did not assess underlying drivers for the observed trends; several events occurred during the assessed period that might have influenced the observed sales patterns, including national, state and local implementation of flavoured e-cigarette restrictions and other population-based tobacco control policies and interventions, as well as the 2019 EVALI outbreak and the COVID-19 pandemic.

CONCLUSION

Unit sales of cooling flavoured e-cigarettes in the USA increased sevenfold during 2017–2021; sales of disposable non-menthol cooling flavoured e-cigarettes experienced the highest percentage increase. By the end of 2021, cooling flavoured e-cigarettes comprised a majority of e-cigarette unit sales. Cooling flavoured e-cigarettes are important to consider when developing strategies to address flavoured e-cigarette use among youth at the national, state and local levels. Additionally, continued surveillance of cooling flavoured e-cigarettes is warranted, including both sales and self-reported use among youth and adults, as well as research to identify factors that might be influencing patterns in sales and use. Further efforts are also warranted to better understand the various categories of cooling e-cigarette products, as well as their health impacts, particularly among young people.

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Contributors FRMA designed the study and performed data analysis and interpretation of the results. ELS and JA assisted in data cleaning and categorisation. FRMA, ELS, MCD and JA wrote the first draft of the paper. BAK contributed to the design of the study and made significant edits to the first draft of the paper. All authors contributed to the review and edit of the paper and take full responsibility for the content of the paper. FRMA is the acting guarantor.

Funding This research was financially supported through Bloomberg Philanthropies grant to CDC Foundation.

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.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available. 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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