

# E-Cigarette Flavors, Devices, and Brands Used by Youths Before and After Partial Flavor Restrictions in the United States: Canada, England, and the United States, 2017–2020

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**Objectives.** To examine the impact of US restrictions implemented in February 2020 prohibiting flavors other than menthol and tobacco in cartridge-based e-cigarettes.

**Methods.** We analyzed 5 cross-sectional waves of the International Tobacco Control Policy Evaluation Project Youth Tobacco and Vaping Surveys, conducted online with youths aged 16 to 19 years in the United States, Canada, and England, for differences in usual e-cigarette flavor, device, and brand reported by past-30-day vapers (n = 9512) before (2017, 2018, 2019), during (February 2020), and after (August 2020) implementation of US flavor restrictions.

**Results.** In August 2020, 78.7% of vapers in the United States reported using a flavor prohibited in cartridges or pods, versus 86.3% in Canada (adjusted odds ratio [AOR] = 1.73; 95% CI = 1.25, 1.40) and 79.8% in England (AOR = 1.10; 95% CI = 0.78, 1.55). Disposable e-cigarettes (exempt from flavor restrictions) increased to a greater extent among vapers in the United States (13.2% to 36.8%) versus Canada (7.7% to 14.2%; AOR = 2.01; 95% CI = 1.33, 3.04) and England (10.8% to 16.4%; AOR = 2.33; 95% CI = 1.52, 3.57). Puff Bar (disposable) emerged as the most popular brand in the United States.

**Conclusions.** Usual flavors used by youth vapers in the United States were unchanged after 2020 restrictions on cartridge-based e-cigarettes. Youths used brands and devices exempt from the restrictions. (*Am J Public Health*. Published online ahead of print May 26, 2022:e1–e11. <https://doi.org/10.2105/AJPH.2022.306780>)

Flavors are a primary reason for tobacco initiation and continued use, particularly among youths and young adults.<sup>1,2</sup> Flavors can increase the appeal of tobacco products through perceptions of improved taste and by decreasing the “harshness” of smoke inhalation.<sup>1,3–5</sup>

Flavors also play an important role in e-cigarette use.<sup>1,6,7</sup> E-cigarettes come in

an array of flavors, ranging from tobacco and menthol to exotic flavors numbering in the thousands.<sup>6,8,9</sup> Fruit is the most popular flavor among younger vapers, followed by mint or menthol, and candy or dessert flavors.<sup>10–12</sup> Fruit flavors are also popular among adult smokers who vape, although to a lesser extent than youths, with greater use of tobacco flavors as the age of adult vapers

increases.<sup>13–15</sup> The use of fruit and other nontraditional flavors has been associated with greater appeal and longer-term use of e-cigarettes among young people and greater satisfaction among adult smokers who vape.<sup>14,16,17</sup>

An increasing number of jurisdictions are implementing restrictions on e-cigarette flavors, with the goal of reducing the appeal of vaping among

young people. In February 2020, the US Food and Drug Administration implemented federal restrictions on the sale of flavors other than tobacco and menthol in cartridge- or pod-based products;<sup>18</sup> the flavor restrictions do not apply to other types of e-cigarettes, such as e-liquids for refillable tank devices or disposable e-cigarettes. Cartridge-based products, such as JUUL, consist of a reusable device that is used with pre-filled e-liquid cartridges or “pods.” The popularity of JUUL and other cartridge or pod brands among young people in the United States and Canada is well-documented.<sup>19,20</sup> In England, however, cartridge or pod e-cigarettes remain less prevalent than refillable tank devices among both youth and adult vapers.<sup>21–24</sup> Disposable e-cigarettes were the least-popular device type in the United States, Canada, and England before 2020.<sup>21,22,25</sup>

In this study, we examined trends in the use of flavored e-cigarettes among past-30-day vapers in the United States, Canada, and England. We examined whether the use of products with flavors other than tobacco or menthol decreased to a greater extent in the United States following implementation of the federal restrictions, compared with Canada and England, where there was no national policy change implemented for these products. We hypothesized that there would be only modest changes in the flavor profile of e-cigarettes among youth vapers in the United States, along with an increase in the use of product types and brands that were exempt from the flavor restrictions, including disposable e-cigarettes. These hypotheses were based on the partial nature of flavor restrictions that apply to only a subset of products, which have previously been shown to have limited impact.<sup>4</sup>

## METHODS

The International Tobacco Control Policy Evaluation Project (ITC) Youth Tobacco and Vaping Survey is a self-completed online survey examining use of tobacco and vaping products among youths in Canada, England, and the United States. Repeat cross-sectional data are reported from the first 5 waves, conducted in July–August 2017, August–September 2018, August–September 2019, February–March 2020, and August 2020.

### Protocol

Participants completed a 20-minute survey, available in English in all countries, as well as in French in Canada. On completion, respondents received remuneration in accordance with their panel's usual incentive structure, which could include points-based or monetary rewards (redeemed for catalog items, as cash, or donated), as well as chances to win monthly prizes.

### Sample

The current study included a subsample of 9512 past-30-day vapers, aged 16 to 19 years, from the United States, Canada, and England, who were recruited as part of the ITC Youth Tobacco and Vaping Survey through Nielsen Consumer Insights Global Panel and their partners' panels, either directly or through their parents. A full description of the study methods can be found in the Technical Reports.<sup>26</sup>

Sociodemographic variables included sex at birth, age, student status, and high-school grades. Race/ethnicity was assessed using country-specific questions with multiple categories, which were recoded to “White (only)” or “else”

(including any other race/ethnicity and not stated) to allow for cross-country comparisons. Smoking behavior was also assessed, as reported elsewhere.<sup>27</sup>

Vapers were asked to indicate the flavor(s) of e-cigarettes or e-liquids they had ever used, and provided with a list: tobacco; mix of tobacco and menthol; menthol or mint; fruit; candy, chocolate, desserts, or sweets; clove or other spice; coffee; a nonalcoholic drink; an alcoholic drink; other flavor; or unflavored. Past-30-day vapers were asked, “In the LAST 30 DAYS, which of these flavours did you use MOST OFTEN?” with a list of the flavors they had selected in the previous question; respondents could select multiple options. In August 2020, menthol and mint were displayed as separate response options, and they have been combined for this analysis unless otherwise specified.

Ever-vapers were asked to indicate the type(s) of e-cigarettes and vaping devices they had ever tried, using either a precoded checklist (in 2017) or “yes/no” items with corresponding product images (from 2018 onward) for the following: disposable (“Disposable [not refillable or rechargeable] e-cigarette/vaping device”), cartridge or pod (“E-cigarette/vaping device with replaceable pre-filled cartridges [or pods]”), and tanks (“E-cigarette/vaping device with a tank that you fill with liquid”). Past-30-day e-cigarette users who had used more than one type were asked which type they used most often, and could select multiple options, except in 2018.

Past-30-day vapers reported the specific brand of e-cigarette or vaping device they “currently use most often,” using country-specific precoded brand lists; respondents could also select “other” and enter the brand name or select “I don't have a usual brand,”

“Don't know,” or “Refused.” Note that the Vype brand in Canada transitioned to Vuse in 2020; therefore, these brands are presented together. Although some vaping brands (e.g., Smok) are offered in a variety of device types, other leading brands are only offered as cartridge or pod products (e.g., JUUL and Vuse) or disposable products (e.g., Puff Bar).

## Analysis

Poststratification sample weights were calculated for each country, based on age, sex, geographic region, and race/ethnicity (United States only). In addition, subsequent survey waves were calibrated back to 2017 for student status (student vs not) and school grades, and used the National Youth Tobacco Survey (NYTS) in the United States and the Canadian Student Tobacco, Alcohol, and Drugs Survey in Canada to calibrate to the trend over time for smoking in the past 30 days. We conducted all analyses on the subsample of respondents who reported vaping in the past 30 days ( $n = 9512$ ).

Weighted estimates are reported unless otherwise noted, and adjusted odds ratios (AORs) and 95% confidence intervals (95% CIs) are reported for models. Separate logistic regression models for each flavor (or device type) were used to test the effects of time and country, adjusting for sex, age (grouped as 16 to 17, or 18 to 19), and race/ethnicity (White [only] vs else); contrasts were used to group the waves as 2017, 2018, and 2019 (preimplementation), compared with August 2020 (postimplementation), as well as with February–March 2020 (during implementation); we estimated country-by-time interaction terms to compare changes over time between countries (e.g., 2017–2019 vs August 2020: Canada vs England). The US flavor

policy implementation deadline was February 1, 2020; although data collection for the February–March 2020 survey occurred after this date, questions asking about past-30-day use would include some time before the implementation deadline for most respondents. Therefore, only the August 2020 data collection was categorized as “post-” flavor restrictions in the United States. However, we conducted sensitivity analyses in which we compared February–March 2020 with the preimplementation period.

We used additional logistic regression models to test country differences within August 2020 for using at least 1 of the flavors prohibited in cartridges or pods (including those listed in Table A, available as a supplement to the online version of this article at <https://ajph.org>) vs using only unrestricted fla-

vors (tobacco, mix of tobacco and menthol, unflavored), adjusting for sex, age group, and race/ethnicity, as well as for mint and menthol separately.

## RESULTS

The sample was limited to past-30-day vapers ( $n = 9512$ ); characteristics are shown by country in Table 1. Table B (available as a supplement to the online version of this article at <http://ajph.org>) shows the characteristics by country at each survey wave.

### Usual Flavors Used by Past-30-Day Vapers

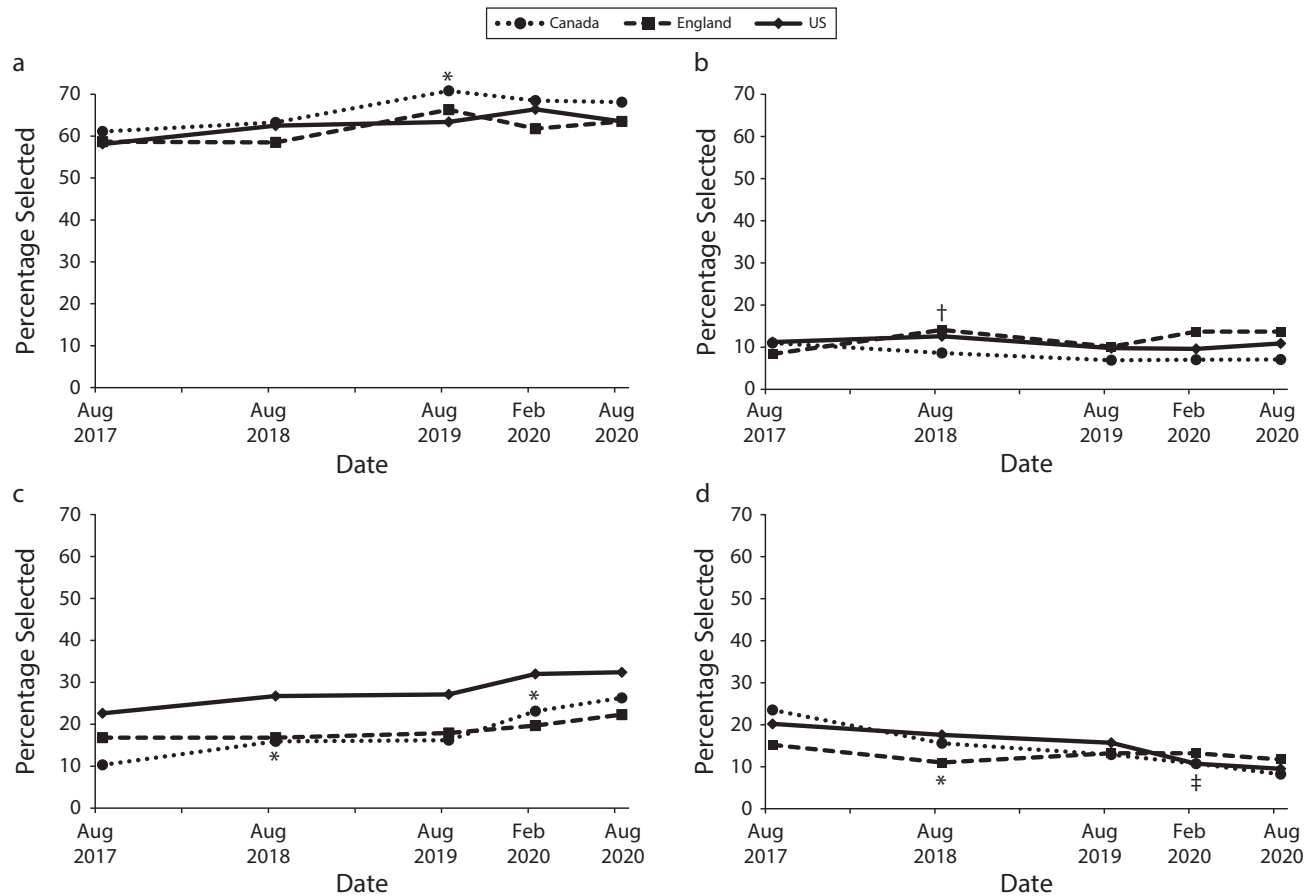
Figure 1 shows the 4 most commonly used flavors among past-30-day

**TABLE 1— Sample Characteristics, Past-30-Day Vapers Aged 16 to 19 Years, by Country: Canada ( $n = 3331$ ), England ( $n = 2262$ ), and United States ( $n = 3919$ ), 2017–2020**

	Weighted % (Weighted No.) or Mean $\pm$ SD		
	Canada	England	United States
Age, y	17.7 $\pm$ 1.00	17.6 $\pm$ 1.00	17.7 $\pm$ 1.00
Sex <sup>a</sup>			
Male	52.5 (1518)	57.9 (1281)	51.6 (1862)
Female	47.5 (1371)	42.1 (931)	48.4 (1745)
Race/ethnicity <sup>b</sup>			
White (only)	62.9 (1816)	80.8 (1787)	79.0 (2850)
Mixed, other, or not stated	37.1 (1073)	19.2 (424)	21.0 (757)
Survey date			
2017	11.8 (340)	15.7 (347)	12.6 (454)
2018	16.0 (463)	15.9 (351)	17.6 (635)
2019	25.5 (888)	19.9 (439)	20.4 (736)
2020 (February–March)	27.9 (805)	27.1 (600)	26.7 (964)
2020 (August)	18.8 (543)	21.5 (475)	22.7 (817)

<sup>a</sup>Determined by response to “sex at birth” survey item; where sex at birth was missing, inferred from gender if “man” or “woman” was selected.

<sup>b</sup>Determined by response(s) to a country-specific survey item with multiple categories, categorized into those who specified only White/European or any other response; wording of the Canadian source question changed slightly, from response option “White” in 2017 to “European” in 2018 to “White or European” from 2019 onward.



**FIGURE 1—** Flavors of E-Cigarettes Used Most Often by Past-30-Day Vapers (n = 9512): (a) Fruit, (b) Tobacco, (c) Menthol or Mint, and (d) Candy, Chocolate, Desserts, or Sweets, by Country: Canada, England, and United States, 2017–2020

Note. “Don’t know” and “Refused” not shown, but retained in denominator. “Menthol” and “mint” were asked as separate items in August 2020 and combined in this analysis for comparability with earlier waves. Data for all flavor categories provided in Table A (available as a supplement to the online version of this article at <https://ajph.org>). The figure for “mix of tobacco and menthol” is available in Figure A (available as a supplement to the online version of this article at <https://ajph.org>).

\*,<sup>†</sup>Significant change from previous wave, within Canada, England, and United States, respectively; model estimates provided in Table D (available as a supplement to the online version of this article at <https://ajph.org>).

vapers. (Table B shows full data for all flavor types, including those not shown in Figure 1, all of which were reported by fewer than 10% of respondents.) As Figure 1 illustrates, in 2020, fruit flavors were the most commonly reported usual flavor in all 3 countries, followed by menthol or mint; candy, chocolate, desserts, or sweets; tobacco; and mix of tobacco and menthol (displayed in Figure A, available as a supplement to the online version of this article at <http://ajph.org>).

**Use of flavors restricted in US cartridges and pods.** In August 2020, 78.7% of youth vapers in the United States reported usually using at least 1 of the flavors prohibited in cartridges and pods (but allowed in other devices), compared with 86.3% in Canada (AOR = 1.73; 95% CI = 1.25, 2.40) and 79.8% in England (AOR = 1.10; 95% CI = 0.78, 1.55).

**Use of restricted flavors (fruit, candy or dessert).** In the United States, no significant differences were observed in the

proportion of youth vapers who usually used fruit flavors before (2017–2019) or after (August 2020) restrictions were implemented (61.8% to 63.5%;  $P = .49$ ). Over the same time period, no significant changes were observed within Canada (66.4% to 68.1%;  $P = .35$ ) or England (61.6% to 63.5%;  $P = .49$ ), with no differences in the effect of time between countries ( $P = .74$  for interaction effect). Sensitivity analyses found an increase between 2017–2019 and February–March 2020 in the

proportion of youth vapers in the United States who usually used fruit flavors (61.8% to 66.4%; AOR = 1.23; 95% CI = 1.01, 1.51), and still no significant differences in Canada or England. Table C (available as a supplement to the online version of this article at <http://ajph.org>) shows the usual use of restricted and unrestricted flavors among the subset of vapers who reported usually using cartridge or pod products.

The use of candy or dessert flavors decreased among vapers in the United States from before to after flavor restrictions (17.5% to 9.5%; AOR = 0.49; 95% CI = 0.35, 0.67), as was the case in Canada (16.0% to 8.2%; AOR = 0.44; 95% CI = 0.31, 0.63), with no differences over time in England (13.1% to 11.7%;  $P = .54$ ). Sensitivity analyses comparing February–March 2020 with 2017–2019 found the same pattern of results.

**Use of mint or menthol flavors.** Before the August 2020 survey, mint and menthol were asked as a single category and could not be separated. When analyzed as a combined category, usual use of menthol or mint flavors increased between 2017–2019 and August 2020 in the United States (25.8% to 32.4%; AOR = 1.41; 95% CI = 1.12, 1.76), Canada (14.8% to 26.3%; AOR = 2.21; 95% CI = 1.71, 2.86), and England (17.2% to 22.3%; AOR = 1.39; 95% CI = 1.02, 1.88). Sensitivity analyses found similar increases between 2017–2019 and February–March 2020 in the United States and Canada, but no significant difference in England (17.2% to 19.7%;  $P = .24$ ).

When analyzed separately using August 2020 data, mint (excluding menthol) was more prevalent in the United States (18.2%; AOR = 1.85; 95% CI = 1.24, 2.77) and Canada (17.9%;

AOR = 1.94; 95% CI = 1.30, 2.91) compared with England (10.6%). In August 2020, 21.0% of vapers in the United States reported using menthol e-cigarettes most often, significantly greater than among vapers in Canada (12.3%; AOR = 1.90; 95% CI = 1.35, 2.67) and England (14.8%; AOR = 1.56; 95% CI = 1.07, 2.27).

**Use of unrestricted flavors (tobacco, mix of tobacco and menthol).** Among vapers in the United States, we observed no changes in the use of tobacco (11.1% to 10.9%;  $P = .94$ ) or mix of tobacco and menthol flavors (6.4% to 6.9%;  $P = .49$ ) before and after flavor restrictions, as was the case in Canada (8.4% to 7.1%;  $P = .36$ , and 4.8% to 4.3%;  $P = .79$ , respectively) and England (10.8% to 13.7%;  $P = .10$ , and 5.8% to 7.7%;  $P = .17$ , respectively) between 2017–2019 and August 2020. Sensitivity analyses comparing 2017–2019 with February–March 2020 found a decrease in mix of tobacco and menthol flavors in the United States (6.4% to 4.2%; AOR = 0.66; 95% CI = 0.45, 0.97), and the increase in tobacco flavor in England reached significance (10.8% to 13.7%; AOR = 1.44; 95% CI = 1.02, 2.03;  $P = .04$ ), with no changes in Canada.

Full estimates from the models for each flavor discussed previously are shown in Table D (available as a supplement to the online version of this article at <http://ajph.org>).

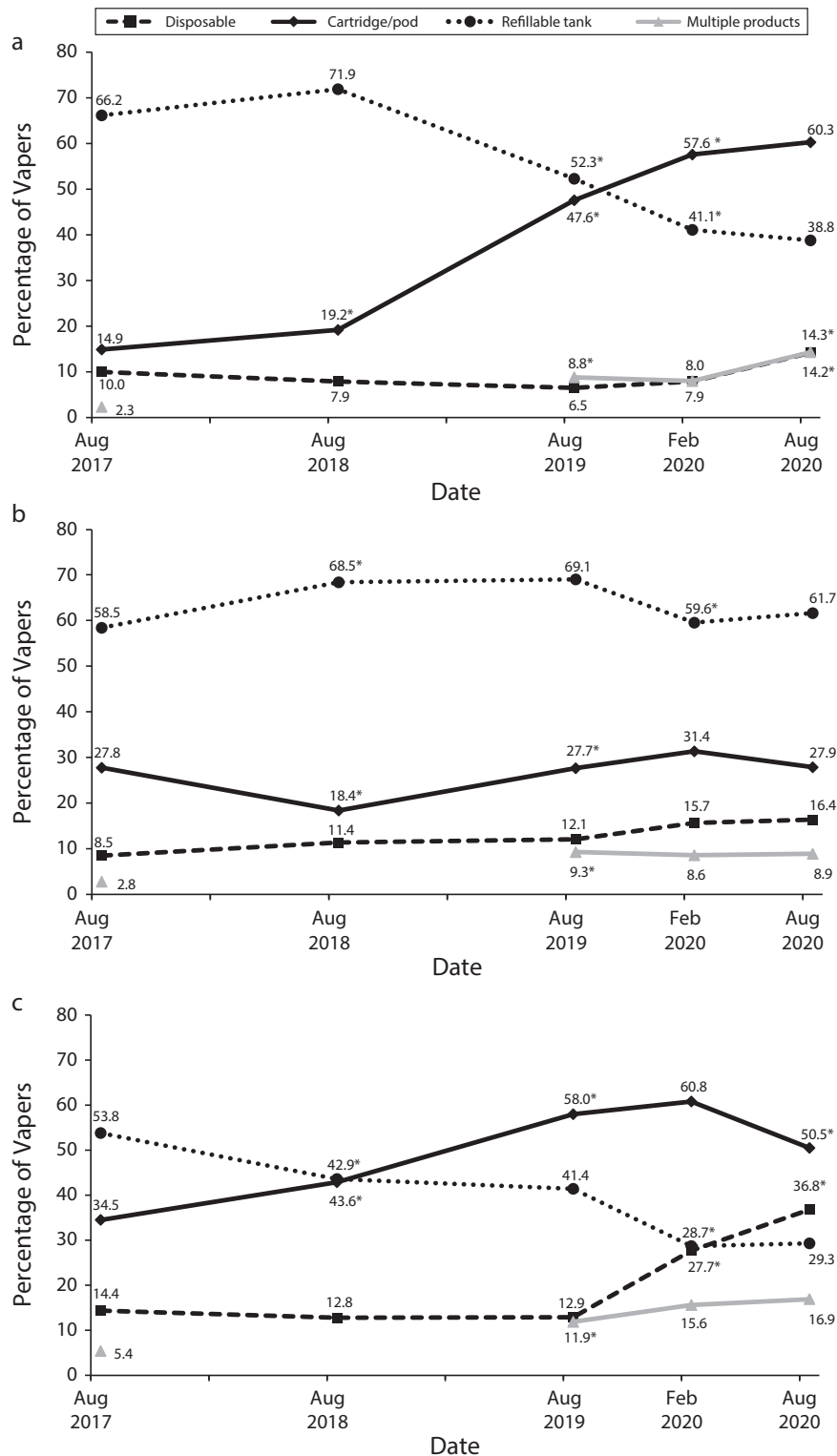
## E-Cigarette Device Type Among Past-30-Day Vapers

Figure 2 shows the device types used most often by past-30-day vapers in each country. Full estimates for each country and year are shown in Table E (available as a supplement to the online version of this article at <http://ajph.org>).

In 2020, US vapers were most likely to report cartridge or pod devices, followed by disposables and refillable tanks. In Canada, cartridge or pod devices were also the most prevalent, followed by refillable tanks and disposables. By contrast, vapers in England were most likely to report refillable tanks, followed by cartridge or pod devices and disposables.

Cartridge or pod devices were more prevalent in August 2020 than in 2017–2019 in Canada (60.3% vs 31.9%; AOR = 4.56; 95% CI = 3.62, 5.74) and the United States (50.5% vs 47.0%; AOR = 1.26; 95% CI = 1.02, 1.55), but did not increase significantly in England (27.9% vs 24.9%; AOR = 1.20; 95% CI = 0.92, 1.58). The increase in cartridge and pod devices between 2017–2019 and August 2020 was greater in Canada compared with England (AOR = 3.79; 95% CI = 2.65, 5.42) and the United States (AOR = 3.63; 95% CI = 2.66, 4.95). Sensitivity analyses comparing the February–March 2020 wave to 2017–2019 indicated similar patterns in Canada and the United States, but the increase in England reached significance (31.4% vs 24.9%; AOR = 1.42; 95% CI = 1.10, 1.83;  $P = .006$ ).

Between 2017–2019 and August 2020, usual use of disposable e-cigarettes increased in all 3 countries (Canada: 7.7% to 14.2% [AOR = 1.98; 95% CI = 1.41, 2.76]; England: 10.8% to 16.4% [AOR = 1.70; 95% CI = 1.20, 2.41]; United States: 13.2% to 36.8% [AOR = 3.97; 95% CI = 3.11, 5.06]), but to a greater extent among US vapers compared with those in Canada (AOR = 2.01; 95% CI = 1.33, 3.04) and England (AOR = 2.33; 95% CI = 1.52, 3.57). Sensitivity analyses comparing February–March 2020 and 2017–2019 found similar patterns in the United States and England, although no



**FIGURE 2— E-Cigarette Device Types Used Most Often by Past-30-Day Vapers, by Wave, in (a) Canada (n = 3331), (b) England (n = 2262), and (c) United States (n = 3919): 2017–2020**

Note. Respondents could select more than 1 response, except in 2018; percentages within country may not add to 100. “Don’t know” and “Refused” not shown, but retained in denominator (n = 18 missing in 2018 and not included). Data for all device categories are provided in Table E (available as a supplement to the online version of this article at <https://www.ajph.org>).

\*Significant change from previous wave, within country; model estimates provided in Table F (available as a supplement to the online version of this article at <https://www.ajph.org>).

difference over time in Canada (7.7% to 7.9%; AOR = 1.03; 95% CI = 0.74, 1.43).

Usual use of refillable tanks decreased between 2017–2019 and August 2020 in Canada (61.2% to 38.8%; AOR = 0.35; 95% CI = 0.29, 0.44) and the United States (45.2% to 29.3%; AOR = 0.47; 95% CI = 0.38, 0.60), but not in England (65.7% to 61.7%; AOR = 0.84; 95% CI = 0.65, 1.08). The decline in tanks was greater in Canada (AOR = 0.42; 95% CI = 0.30, 0.59) and the United States (AOR = 0.56; 95% CI = 0.40, 0.79) compared with England. Results were similar in sensitivity analyses comparing February–March 2020 with 2017–2019, except that the decrease in tanks was significant in England (65.7% to 59.6%; AOR = 0.77; 95% CI = 0.61, 0.97;  $P = .02$ ).

Finally, the use of multiple product types increased in all countries between 2017–2019 and August 2020 (Canada: 6.7% to 14.3% [AOR = 3.65; 95% CI = 2.19, 6.08]; England: 6.5% to 8.9% [AOR = 1.77; 95% CI = 1.05, 2.96]; United States: 9.4% to 16.9% [AOR = 2.37; 95% CI = 1.67, 3.37]), with no significant differences in the effect of time between countries ( $P = .12$  for interaction effect). Sensitivity analyses comparing February–March 2020 and 2017–2019 found consistent results.

Full estimates from the models for each device type are shown in Table F (available as a supplement to the online version of this article at <https://ajph.org>).

## E-Cigarette Brand

Figure 3 shows the 5 most common “usual” brands among past-30-day vapers in each country in August 2020, as well as trends in these brands over time. (The 10 most commonly selected usual brands in each country and survey wave are listed in Table G, available as a supplement to the online version

of this article at <http://ajph.org>.) In 2020, Smok, JUUL, and Vype/Vuse were among the top brands in all 3 countries. In the United States, Puff Bar was the most popular brand among youth vapers in August 2020. The findings also indicate the decreasing proportion of past-30-day vapers who reported not having or not knowing their usual brand, in all 3 countries.

## DISCUSSION

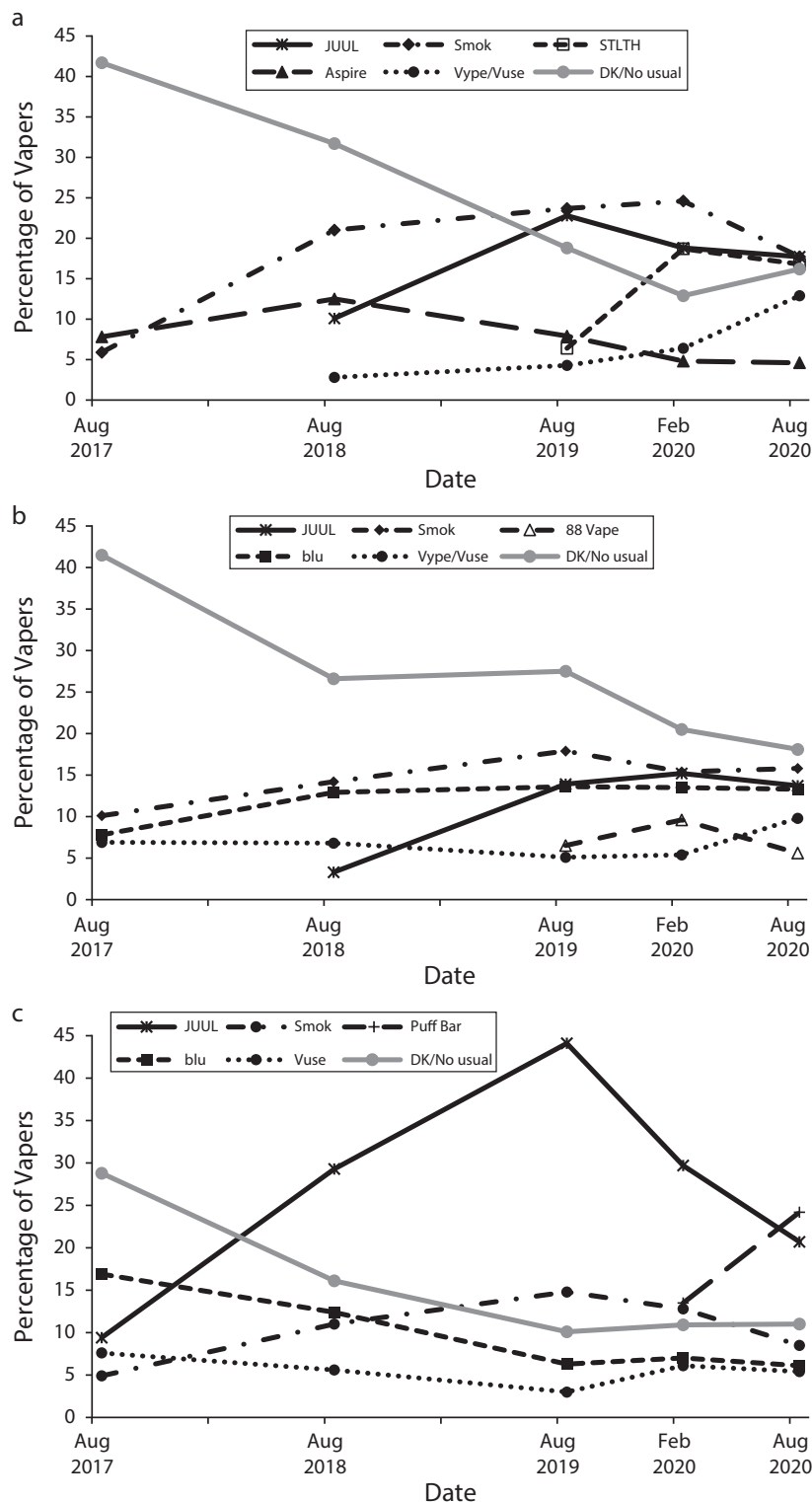
Few, if any, changes were observed in the flavors used most often by youth vapers in the United States following federal restrictions on nontobacco and nonmenthol flavors in cartridge-based e-cigarettes in early 2020. Fruit remained the most popular usual flavor among youth vapers in all 3 countries. Trends before and after the US flavor restrictions were implemented were no different in the United States compared with Canada and England, with the exception that the decrease in candy- or dessert-flavored products was marginally greater in Canada. In 2020, usual use of menthol or mint flavors increased among youths in the United States; although the study did not distinguish between “mint” and “menthol” before the flavor restrictions, youth vapers in the United States were equally or more likely to report using “mint” products in August 2020 after they were partially restricted, compared with those in Canada and England.

The findings suggest that the main impact of the US flavor restrictions on cartridge-based e-cigarettes among youths was a shift to disposable products, which were not subject to flavor restrictions. Past-30-day vapers in the United States were considerably more likely to report using disposable devices in 2020, with smaller increases in the

use of disposable products in Canada and England. US trends in usual e-cigarette brands were consistent with the shift in device types: Puff Bar, a disposable device that was not subject to the flavor restrictions, rose from 0% in 2019 to the leading brand among youth vapers in 2020. Puff Bar has a nicotine profile similar to JUUL<sup>28</sup> and is notable for its claim that the product contains synthetic nicotine, raising questions about the applicability of regulatory standards to the growing number of such products.<sup>29,30</sup> The data suggest that the rise of disposable products like Puff Bar came at the expense of JUUL, consistent with other youth surveys in the United States.<sup>31</sup> Although JUUL ceased selling flavors other than tobacco, menthol, or mint in US retail stores in November 2018, before the February 2020 federal regulation, JUUL continued to sell flavored pods online, and sales data indicate a major decline in JUUL after the February 2020 regulation.<sup>12</sup> Notably, JUUL also ceased sales of flavors other than tobacco or mint in Canada in January 2020, which corresponded with the increase we observed in mint-flavored products among Canadian youths.

Although the primary effect of the US flavor restrictions was a shift toward disposable products, a substantial number of vapers continued to use cartridge or pod products with the restricted flavors. For example, in August 2020, 53% of cartridge or pod vapers in the United States reported usually using fruit flavors. Thus, noncompliance with the flavor restrictions appears to be widespread.

The current results are consistent with findings from US surveys,<sup>32</sup> including the NYTS, in which the use of disposable products increased from 2% in 2019 to 27% in 2020 among US high-school



**FIGURE 3— E-Cigarette Brands Used Most Often by Past-30-Day Vapers, in (a) Canada (n = 3331), (b) England (n = 2262), and (c) United States (n = 3919): 2017–2020**

Note. “Don’t know” and “Refused” not shown, but retained in denominator. Data for the top-10 brand categories are provided in Table G (available as a supplement to the online version of this article at <https://www.ajph.org>).



students.<sup>33,34</sup> Fruit remained the most commonly used flavor, followed by mint, menthol, and candy, desserts, or other sweets.<sup>35,36</sup> Retail sales data between August 2019 and May 2020 also indicate a rise in disposable e-cigarettes, and a marked shift from mint to menthol flavors in cartridge and pod products.<sup>37</sup> The distinction between “mint” and “menthol” warrants closer examination. Flavor restrictions in the United States are based upon brand descriptors, rather than the chemical constituents of the flavorants themselves, and menthol and mint are often used interchangeably in product names.<sup>35</sup> For example, menthol is a primary flavoring ingredient in JUUL “mint” pods in Canada and the United States.<sup>36</sup> Therefore, restricting “mint” but not “menthol” products may have limited impact on appeal to young people or on patterns of use.

The current findings from England are consistent with other national survey data showing increased use of fruit flavors between 2015 and 2021 among youths (from 42% to 52%), and substantial reductions in tobacco flavor (from 23% to 1%),<sup>24</sup> with few changes among adult vapers in England since 2017.<sup>25</sup> The findings provide additional evidence of differences between vaping markets in England and those in the United States and Canada: in England, youths and adults are considerably more likely to use refillable tanks than cartridge or pod devices, and less likely to use higher-nicotine, salt-based products.<sup>4,13,21,23–25</sup> We are unaware of any recent Canadian evidence with which to compare the current results.

## Limitations

The current study is subject to limitations common to survey research, including the potential for response

bias. Participants were drawn from commercial panels and not recruited using probability-based sampling; therefore, the findings do not necessarily provide representative estimates within each country. However, the same methodology was used across countries and survey years and post-stratification weights were used to weight the sample on sociodemographic factors.<sup>31</sup> Recall of product data, including brand and flavor profile, is subject to recall error and potential bias: some degree of misclassification would be expected, particularly among infrequent vapers who may be less familiar with specific brands. To promote more accurate reporting, the study used precoded lists and allowed open-ended “other” responses.

Finally, the current study did not assess changes in prevalence associated with the flavor restrictions. The flavor restrictions in the United States coincided with the onset of COVID-19 restrictions in the 3 countries. The pandemic had an important impact on both vaping and smoking behaviors among young people,<sup>32,38</sup> such that changes in prevalence of use over this period cannot reliably be attributed to specific policy factors. Accordingly, we have focused on more “proximal” outcomes of the use of e-cigarette flavors, which are directly associated with the regulatory objective of flavor policies and less subject to general pandemic effects.

## Public Health Implications

E-cigarette flavors reported by youth vapers in the United States, including fruit and candy, were largely unchanged after restrictions on cartridge-based e-cigarettes were implemented in 2020. Youth vapers in

the United States appear to have circumvented the flavor restrictions by using device types exempt from the restrictions. The findings highlight the versatility of the e-cigarette market; accordingly, flavor restrictions and other product standards are likely to have greater impact if they are applied across all market segments.

As of 2021, a number of US states and Canadian provinces have implemented more comprehensive flavor restrictions. Future studies should examine the impact of such policies on youths and on e-cigarette use among adult smokers who vape as a method of quitting smoking. **AJPH**

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## CONTRIBUTORS

D. Hammond conceptualized and designed the study, with assistance from J. L. Reid. J. L. Reid coordinated and supervised data collection. R. Burkhalter led the data analysis, with assistance from J. L. Reid. D. Hammond and J. L. Reid led the article preparation. All authors contributed to the article writing and interpretation of results, and

reviewed and revised the article. All authors approved the final article as submitted and agree to be accountable for all aspects of the work.

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## CONFLICTS OF INTEREST

D. Hammond has served as a paid expert witness on behalf of governments and public health authorities in legal challenges against tobacco and vaping companies. The other authors have no conflicts of interest relevant to this article to disclose.

## HUMAN PARTICIPANT PROTECTION

This study was reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#21847/31017) and the King's College London Psychiatry, Nursing, and Midwifery Research Ethics Subcommittee.

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