

Online popularity of JUUL and Puff Bars in the USA: 2019–2020

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ABSTRACT

Background The US Food and Drug Administration (FDA) announced a flavour ban on cartridge-based e-cigarettes in January 2020. It is unclear whether e-cigarette users will switch to disposable vaping products with a variety of kids-appealing flavours available. **Methods** We performed piece-wise regression and autoregressive integrated moving average (ARIMA) algorithms to compare the relative search volume (RSV) of JUUL and Puff Bar (a disposable vaping product) using the 1-year Google Trends data from 24 February 2019 to 20 February 2020, separated by three events that may have spurred changes in RSV for each product.

Results The RSV for JUUL was relatively stable before Trump Administration announced plans to ban flavoured e-cigarettes. After that, the RSV for JUUL dropped sharply (rate of change = -8.8 per week) from 11 September 2019 to 17 October 2019 when JUUL Labs announced to halt online sales of some flavoured products, and the RSV resumed the decreasing trend after FDA announced enforcement policy of cartridge-based e-cigarettes on 2 January 2020. In comparison, the RSV for Puff Bar started to increase after 11 September 2019 with a low rate of change (0.6) until 17 October 2019. After that, the increase in RSV for Puff Bar accelerated. The RSV of puff bars surpassed that of JUUL during the week of 2 February 2020.

Conclusion The popularity of Puff Bar on Google Search suggests that users may replace cartridge-based vaping products with disposable e-cigarettes in the circumvention of the partial flavour ban. Continuous surveillance and further assessment are needed to prevent potential loopholes in tobacco regulation.

The prevalence of current e-cigarette use increased dramatically during 2017–2019 among US adolescents.^{1,2} In 2019, more than one in four students in the 12th grade and more than one in five in the 10th grade reported using e-cigarettes in the past 30 days.¹ Meanwhile, e-cigarette use prevalence increased from 4.7% in 2016 to 7.6% in 2018 among US young adults aged 18–24 years.³ Flavoured e-cigarette products, including candy and fruit, are widely available and flavouring has become one of the leading reasons for current tobacco use among youth.⁴ Recently the pod-mod style e-cigarette products like JUUL have experienced rapid market growth.⁵ These devices resemble USB flash drives, contain nicotine salts to mimic the sensation of smoking cigarettes, and deliver high nicotine concentrations that can lead to nicotine addiction. The US Food and Drug Administration (FDA) announced a ban of cartridge-based e-cigarettes in flavours other than tobacco and menthol in

January 2020 and the enforcement action went into effect on February 6, 2020.⁶

A potential public concern is that youth may switch from cartridge-based vaping products to other disposable e-cigarettes,⁷ such as Puff Bar, Posh and Stig, which are currently excluded from the flavour ban. These precharged and prefilled vaping products include a variety of flavours and have similar sleek design and nicotine salt ingredients as JUUL. Some of these products also have a high nicotine level (eg, above 5%). Prior studies have reported that these products can be easily found online with a price lower than JUUL.^{8,9}

Public policies and major events related to e-cigarettes can play a significant role in informing and shaping public perception and people's use of e-cigarettes, and e-cigarette news media is reaching the public.^{10,11} Wackowski *et al*¹² reported that discussion about flavour bans quadrupled from 6.1% in 2015 to 24.6% in 2018 in e-cigarette news coverage in the USA and JUUL was mentioned in 50.8% of 2018 online news articles of e-cigarettes. Given the rapidly evolving e-cigarette markets and changes in regulations and policies of vaping products, online surveillance systems, such as Google searches, may have advantages than traditional surveys to identify the emerging trends of online customer behaviours.^{13,14} This study sought to compare the relative search popularity between the disposable vaping products of Puff Bar and the pod-mod style of JUUL, using the surveillance of Google Trends data from 24 February 2019 to 22 February 2020. We hypothesise that there was a decreasing trend in search popularity of JUUL in comparison with the growing popularity of Puff Bar, coinciding with the events that may have spurred the changes in searches of these two products.

METHOD

Data and measure

Google Trends data shows how often a particular term is searched in Google relative to the total search volume across various regions and time horizons. We searched Google Trends with key terms 'Puff Bars' or 'Puff Bar' in the 1-year period in the USA. We also searched the key terms of 'JUUL' or 'JUULing'¹⁵ as a comparison group. Google Trends returned data on the relative search volume (RSV), measuring the number of searches conducted for a selected keyword (eg, 'JUUL+JUULing') divided by the total number of Google Search counts conducted at the same geography and time range. The two RSV trends use a standardised scale, normalised between 0 and 100 where the time period with the highest RSV gets assigned a value of 100 and other time periods get assigned a value relative to 100.¹⁶



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As the RSVs for JUUL and Puff Bar are adjusted by the same values (ie, the overall search volume and the highest value from both trends), we are able to compare the relative popularity by examining results from RSVs of these two products.

Given that Google Trends provide daily data only on a 90-day search period, we reported the comparisons of Google Trends between JUUL and Puff Bars on a weekly basis.

We identified three major events that may have spurred the changes in Google RSV for both products: (1) on 11 September 2019, Trump Administration announced plans to ban flavour ban¹⁷; (2) on 17 October 2019, JUUL Labs announced to halt online sales of its sweet and fruity e-cigarette products¹⁸; (3) on 02 January 2020, FDA finalised enforcement policy on unauthorised flavoured cartridge-based e-cigarettes.⁶ Accordingly, we created four time periods in the study sample to measure the changes in Google RSV related to these events:

- ▶ Time period 1: 24 February 2019 to 11 September 2019.
- ▶ Time period 2: 11 September 2019 to 17 October 2019.
- ▶ Time period 3: 17 October 2019 to 02 January 2020.
- ▶ Time period 4: 02 January 2020 to 22 February 2020.

Statistical analyses

The weekly Google RSV for JUUL and Puff Bar were plotted to visualise the temporal trends. Autoregressive integrated moving average (ARIMA) algorithms by Hyndman and Khandakar¹⁹ were performed on time period 1 (baseline before events) to forecast the expected values of RSVs in time periods 2–4 (assuming no event impacts). To assess the event impact, separate linear regression models were conducted for Google RSV in each time period. The regression coefficients of slope (b) and p values were reported to measure the rate of change of Google RSV for JUUL and Puff Bar. The ARIMA analyses were computed using

R software V4.0 and regression analyses were performed using SAS 9.4. P values <0.05 were considered statistically significant.

RESULTS

As shown in figure 1, the Google RSV for JUUL was relatively stable before Trump Administration announced plans to ban flavoured e-cigarettes on 11 September 2019. After that, there was a steep drop in RSV until JUUL announced to halt online sales of some flavoured e-cigarettes on 17 October 2019. The RSV for JUUL resumed the decreasing trend after FDA announced the enforcement policy of flavoured e-cigarettes on 02 January 2020. There was a large gap between expected RSVs (dotted line) and actual RSVs (solid line) after 11 September 2019.

There was a very low RSV for Puff Bar before 11 September 2019 (range, 0–2, median <1). The RSV for Puff Bar started to have a rapid increase after JUUL's announcement (17 October 2019). The RSV for Puff Bar surpassed that for JUUL (44 vs 37) during the week of 02 February 2020. The actual RSVs (solid line) for Puff Bar were significantly higher than the expected RSVs (dotted line).

Table 1 presents the rate of change for JUUL and Puff Bar across four time periods. The Google RSV for JUUL decreased slightly (rate of change = -0.2 per week; 95% CI -0.3 to 0.0) prior to the announcement of the flavour ban on September 11 and then dropped sharply until JUUL announced halts of online sales of some flavoured e-cigarettes (rate of change = -8.8 per week; 95% CI -12.9 to -4.7). The rate of change for RSV of JUUL was not significant from 17 October 2019 to 02 January 2020 (p=0.1927) and started to decrease again after the FDA announced the enforcement policy on cartridge-based e-cigarette products (rate of change = -2.1 per week, 95% CI -3.0 to -1.2). In comparison, the RSV for Puff Bar started to increase

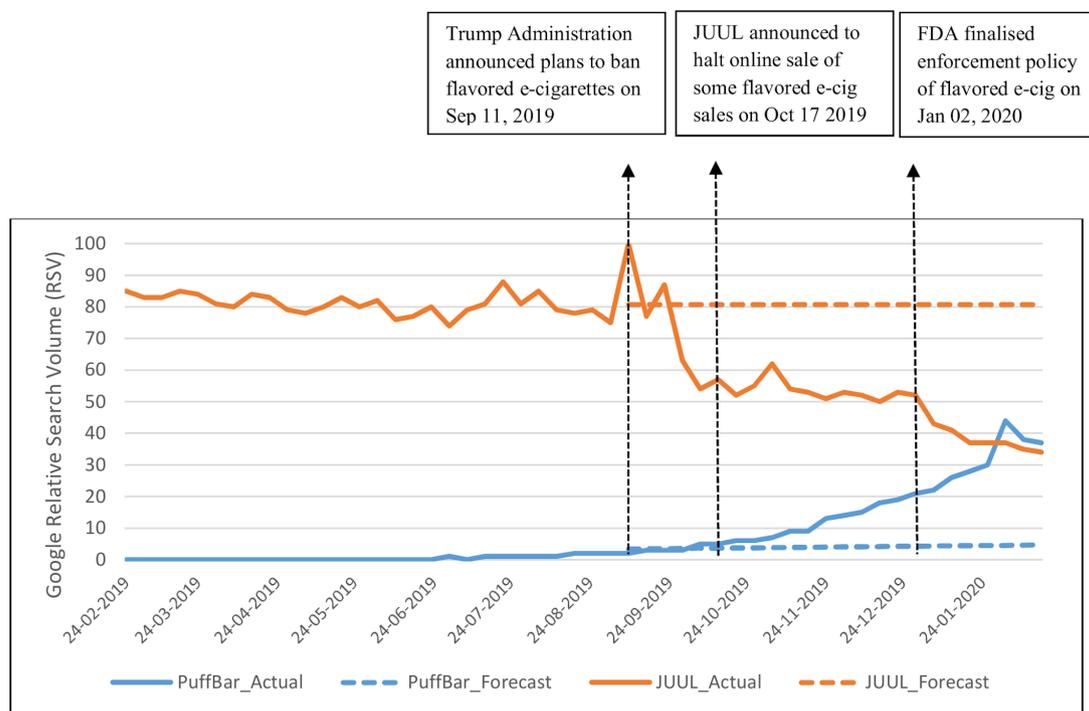


Figure 1 Overall Google Trends in comparison of 'Puff Bar' vs 'JUUL', 24 February 2019–22 February 2020. * ARIMA, autoregressive integrated moving average; FDA, Food and Drug Administration; RSV, relativesearch volume. *The RSV was collected on a weekly basis from February 24, 2019 (week 1) to February 22, 2020 (week 52). The solid curve is for actual Google RSV. The dotted curve stands for the expected values of RSV using the ARIMA algorithm.

Table 1 Rate of changes for overall Google Trends across different time periods: JUUL vs Puff Bars

Overall Google Search Time	JUUL		Puff Bar	
	Google RSV rate of change/week	P value*	Google RSV rate of change/week	P value*
24 Feb 2019–11 Sep 2019	−0.2 (−0.3 to 0)	0.0251	0 (0–0.1)	N/A
11 Sep 2019–17 Oct 2019	−8.8 (−12.9 to −4.7)	0.0134	0.6 (0.3–0.9)	0.0102
17 Oct 2019–02 Jan 2020	−0.5 (−1.2 to 0.2)	0.1927	1.6 (1.4–1.8)	<0.0001
02 Jan 2020–22 Feb 2020	−2.1 (−3 to −1.2)	0.0034	3.0 (1.7–4.2)	0.0037

*Separate linear regression models were conducted with Google RSV as the dependent variable and time (week) as the independent variable. RSV, relative search volume.

after 11 September 2019 with a low rate of change (0.6 per week; 95% CI 0.3–0.9) before the JUUL's announcement on 17 October 2019. After that, the increase in RSV for Puff Bar started to accelerate with a rate of change of 1.6 per week (95% CI 1.4–1.8) between 17 October 2019 and 02 January 2020 and 3.0 per week (95% CI 1.7 to 4.2) between 02 January 2020 and 22 February 2020.

DISCUSSION

This study used the Google Trends data to report a drop of Google RSV for JUUL and a surge of Puff Bar in the online search beginning the fourth quarter of 2019. Those changes in search popularity of these two products coincided with a series of events related to the rapidly evolving flavoured vaping products, and the online search for Puff Bar has surpassed that for JUUL since early February of 2020 when the FDA's flavour ban went into effect. The surge in youth e-cigarette use along with the widely available flavoured being the top reasons for vaping among youth⁴ had led the regulatory proposals to restrict the sales of flavoured e-cigarette products. However, the recently finalised FDA enforcement policy was limited to the flavoured cartridge-based e-cigarette products,⁶ leaving the door open for the open-tank and disposable vaping products. The surge in an online search of Puff Bar suggests that these disposable e-cigarette products are gaining popularity and have started to fill the retail shelf to replace JUUL and other pod-mod style e-cigarette products in a very short period.

Traditional tobacco survey data may be lagged to report the self-reported use of new emerging products. Previous studies have shown that Google Search data can be effective in predicting influenza detection²⁰ and identifying online sales of marijuana,²¹ internet searches for cannabidiol²² and e-cigarette use.^{13 14} This study added to the existing literature by using online real-time search data to detect and monitor the rapidly changing vaping products. Our findings suggest that some disposable e-cigarette makers like Puff Bar may have exploited the loophole in the current FDA flavour ban that narrowly targets the cartridge-based e-cigarettes. A recent blog reported that the vaping industry has swooped in advertisements targeting millions of teens who are stuck at home during the COVID-19 crisis with online messages such as 'stay sane with Puff Bar this solo-break because it is the perfect escape from the back-to-back zoom calls and parental texts'.²³ Continuous online surveillance of new vaping products is critical to inform future regulatory actions against vaping products that may be appealing to youth.

This study is subject to a few limitations. First, Google Trends data are based on a limited number of search terms that may not capture the complete Google Search for Puff Bar and JUUL products. Second, this study only focused on one popular disposable e-cigarette product, Puff Bar. There are many other similar products reported in the market⁹ and future studies should continue to monitor the popularity of other brands and examine the effects

of those disposable vaping products on youth use of e-cigarettes. Third, this study used the weekly Google Trends data instead of daily data due to the study period longer than 90 days. Thus, some granular shifts (eg, exact date) may not be fully captured in our analysis. In addition, unlike some other Google Search studies,^{13 21} we did not report the estimated raw search counts due to the limitation to access to vendor tools (eg, comScore.com or Google Adwords' search volume estimator). However, because Google RSV provides a valid comparison of relative search popularity for the outcome of interests, adding the absolute estimated search counts will unlikely provide additional insights beyond our current findings. Lastly, this study did not consider where JUUL and Puff Bar are typically purchased. For instance, JUUL is primarily bought on brick and mortar stores and its own website, whereas the Puff Bar is primarily sold online from many vendors. The rising in Google Search of Puff Bar starting the fourth quarter of 2019 may be partly because consumers know where to find JUUL but need to search for Puff Bar.

CONCLUSION

This study identified a surge in the RSV of Puff Bar in comparison with the declining popularity of JUUL since the fourth quarter of 2019, and the RSV of Puff Bar surpassed that of JUUL in February 2020. E-cigarette users may shift from cartridge-based e-cigarettes to disposable vaping products, thus limiting the effects of the newly announced ban on flavoured e-cigarettes.

What this paper adds

- ▶ Given the increase in youth e-cigarette use, the Food and Drug Administration has announced a ban on the cartridge-based e-cigarette products with flavours other than tobacco or menthol.
- ▶ The Google relative search volume of Puff Bar, a disposable vaping product, has surpassed that of JUUL since February 2020.
- ▶ E-cigarette users may shift from cartridge-based e-cigarettes to disposable vaping products, thus limiting the effects of the newly announced ban on flavoured e-cigarettes.

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