

Research Article

Youth Patterns of Use of Electronic Nicotine Delivery Systems (ENDS) Use, Population Assessment of Tobacco and Health (PATH) Waves 4 – 5.5

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Introduction: Youth use of electronic nicotine delivery systems (ENDS) is a continuing concern, making it important to assess evolving patterns, especially as non-tobacco, non-menthol (NTM) flavors were withdrawn for pod-based (but not disposable) ENDS in February 2020.

Methods: Trends in past-30-day (P30D) ENDS use and smoking prevalence, usual device type, flavor (tobacco, mint/menthol, or fruit/sweet/other), and regular/last-used brand in PATH Waves 4 (2017), 4.5 (2018), 5 (2019), and 5.5 (2020) were examined. Shifts between 2019–2020 in flavor use for pods and disposables were examined. Wave 5.5 is uninformative regarding brand use because common disposable brands were not queried.

Results: P30D ENDS use peaked in 2019 at 8.6% of all youth, subsequently declining by nearly half to 4.5% in 2020. Meanwhile, P30D cigarette smoking declined to an all-time low (1.3%) in 2020.

Within this overall decline, consumption shifted to disposable ENDS, which increased nearly 10-fold (from 5.0% to 49.2% of P30D ENDS users). Relatedly, use of fruit/sweet/other flavors remained similar overall between 2019 and 2020 (approximately 75%–80% of P30D ENDS users), but the use of these flavors became concentrated in disposable ENDS in 2020 (a 12-fold increase from 4.4% to 58.4% of fruit/sweet/other-flavor users).

Conclusions: PATH results show similar trends to other US national surveys in youth ENDS trends. The removal of non-tobacco, non-menthol flavors in pod-based ENDS (while remaining available in disposables) has likely driven youth towards disposable devices, resulting in continued high use of fruit/sweet/other flavors, which are now predominant in users of disposable ENDS.

Introduction

Youth tobacco use in the US remains a public health concern ^[1]. Of particular interest are cigarettes, which are the most harmful form of tobacco ^[2], and electronic nicotine delivery systems (ENDS), which are now the most commonly used tobacco product among youth ^{[1][3]}. Given the importance of youth prevention, as well as the diversification of the tobacco product market, ongoing surveillance from multiple sources is warranted. In the US, several national youth surveys track tobacco use, including the National Youth Tobacco Survey (NYTS), Monitoring the Future (MTF), and the Population Assessment of Tobacco and Health (PATH).

To date, NYTS and MTF are consistent in showing that ENDS use increased to a peak in 2019, and has declined since, through 2022 ^{[3][4][5][6]}. These overall trends are very consistent between NYTS and MTF, despite minor differences in point estimates. Similarly, both NYTS and MTF show continual declines in cigarette smoking prevalence, to all-time lows in 2022 ^{[3][5]}.

The ENDS market is heterogenous and continues to evolve, from older-generation ‘cig-a-likes’ to devices with refillable tanks, to devices with prefilled pods or cartridges ^{[7][8]} and, most recently, disposable devices ^{[9][10]}. Both NYTS and PATH show that leading up to the 2019 peak in youth ENDS use, youth predominantly used ENDS devices with prefilled pods/cartridges ^{[10][11]}, consistent with JUUL being the most commonly reported brand ^{[4][12]}. Additionally, ENDS products were available in a variety of flavors such as fruit or candy/desserts, in addition to more ‘traditional’ tobacco and menthol flavors. Youth most often reported use of non-tobacco, non-menthol flavored ENDS ^[4].

However, the ENDS market has been quite dynamic, and subject to legal and regulatory influences, two of which specifically impacted non-tobacco, non-menthol flavors of pod/cartridge-based devices. First, JUUL (a major brand of pod/cartridge-based ENDS) voluntarily removed non-tobacco, non-menthol flavors between late 2018 to late 2019.¹ Shortly afterwards (February 2020), FDA announced enforcement actions expressly against non-tobacco, non-menthol flavors in pod-based devices – but not expressly against other ENDS device types such as disposables ^[13]. Since then ^[14], flavored disposable cartridges have remained on the market, notwithstanding their less-certain legal status. Youth patterns of ENDS use subsequently changed in notable ways, likely as an adaptation to this marketplace condition. For example, in NYTS, the use of pod-based devices as a share of P30D ENDS use fell from 54.0% in 2019 to 25.2% in 2022, as the use of disposables rose from 2.6% to 55.3% ^{[5][15]}.

Trends in reported brand use are consistent with this shift towards disposables: in 2020, JUUL was the most frequently-reported usual brand, but this had dropped to being the 4th most common reported usual brand in 2021 [16], giving way to Puff Bar, a disposable ENDS brand. Notably, however, use of flavors remained high overall, as disposable ENDS were still offered in non-tobacco, non-menthol flavors [16]. MTF data corroborate these trends [12]. Thus, evidence to date from multiple youth surveys show that, in the context of an overall decline in ENDS use, youth maintained prevalent use of non-tobacco, non-menthol flavors, with a large-scale shift from pod-based ENDS to disposable devices, after non-tobacco, non-menthol flavors became unavailable in pod-based devices, but continued to be available in disposables.

PATH is another rigorous and highly-utilized nationally-representative survey on youth patterns of tobacco use, sponsored by the US Food and Drug Administration (FDA), and comprising nationally-representative samples. Understanding evolving patterns of youth tobacco use in PATH would be informative. Estimates of P30D ENDS use prevalence from PATH have been quite different from those in NYTS and MTF (e.g., ~8.6% ENDS use prevalence in PATH in 2019 [11] vs. ~20.0% in NYTS [17] and 22.5% in MTF [18]), suggesting it may tap a different sample or different phenomenon. Since the release of PATH data typically lags by two years, PATH data has not, until recently, been available to examine the above trends after 2019 and the national removal of non-tobacco, non-menthol flavored pod-based ENDS products. The current study examines the recently-released PATH Wave 5.5 data, collected in 2020, with respect to trends in prevalence and patterns of use.

Methods

Data and sample

PATH youth public-use files from Waves 4 to 5.5 were used, providing approximately annual estimates from 2017 to 2020 (Wave 4: December 1, 2016 to January 3, 2018; Wave 4.5: December 1, 2017 to December 1, 2018; Wave 5: December 1, 2018 to November 30, 2019; and Wave 5.5: July 3, 2020 to December 1, 2020), as this covers the time period from the most rapid rise in ENDS use [19][20] to the most recent available data. These analyses used the Wave 4 Cohort and included 14,793 youth in Wave 4, 12,918 in Wave 4.5, 11,976 in Wave 5, and 7,129 in Wave 5.5.

Because the age range of administration differed across waves (i.e., surveys were administered to respondents aged 12-17, with the exception of Wave 5.5 (2020) which was administered to

respondents aged 13-17), we present supplementary analyses on a subset of the sample which has approximately the same age range across *all* waves, by restricting analyses to only respondents continuing from the prior wave (i.e. who were at least 12 years old in the prior wave but would be approximately one year older following wave). For the supplemental analysis, there were 9,360 youth in wave 4, 11,258 in wave 4.5, 10,324 in wave 5, and 7,076 in wave 5.5. Wave 5.5 also differed in the mode of survey administration, with interviews being conducted via telephone due to COVID, as opposed to in-person interviews in prior waves.

Measures

P30D ENDS use was assessed as any use of electronic vaping products in the past 30 days. P30D cigarette smoking was assessed as any use of cigarettes in the past 30 days.

ENDS device type was assessed among P30D ENDS users as the device type used *most often*, starting in Wave 5 (2019). Response options included: disposable, replaceable filled cartridges (pods), tank that you refill with liquid, mod system, or something else.

Reported regular/last-used ENDS brand is a PATH-derived variable that combines respondents' reported *regular brand* among those who *have* a regular brand, and reported *last-used* brand among those who do *not* have a regular brand (including those who only ever used ENDS once). The list of brands explicitly included in PATH data changed in each wave (Supplemental Table 1); most of the brands were explicitly listed as response options, but sometimes were recoded from common write-in responses. For example, JUUL use was recoded from write-in responses only (i.e. was not presented as an explicit response option) up through Wave 4.5 (2018), but starting in Wave 5 (2019), JUUL was added to the presented list of response options (see Supplemental Table 1). Wave 5.5 (2020) brand data included some brands with disposable products (e.g. EZ Smoker, E-Swisher, and Mystic), but notably did *not* include any commonly-used disposable brands identified in other youth surveys from the same year, particularly Puff Bar ^{[12][21]}. "Some other brand" is coded by the PATH team as a collective response category that includes all other brand responses.

ENDS flavor was assessed as select-all-that-apply question among P30D ENDS users. Response options included: "tobacco," "menthol/mint" (a combined category in PATH), "fruit," "candy/dessert/sweet," "chocolate," "clove/spice", "alcoholic drink," "non-alcoholic drink," and some other flavor not listed). In these analyses, fruit, candy/dessert/sweet, chocolate, clove/spice, alcoholic drink, non-alcoholic drink, and other flavor were combined into a single category

(“fruit/sweet/other”), consistent with previous PATH publications [22] and due to their similar regulatory status. Flavors were asked about in general and not linked to any brand or device type.

Analyses

Overall P30D prevalence of ENDS use and cigarette smoking were calculated as percentages. Device type and regular/last-used brand was also calculated among P30D ENDS users. ENDS flavors used in P30D were calculated by usual device type over the years in which device type was assessed (2019 and 2020), in order to examine changes that may have resulted from the widespread removal of pod-based ENDS products with non-tobacco, non-menthol flavors, though we could not confirm whether a reported flavor was used on the primary device type or another. All analyses were weighted using the provided single-wave weights with balanced repeated replication to provided weighted frequencies for estimating population prevalence and to account for complex survey design and the presence of some of the same respondents in more than one wave [23]. Chi-Square tests (Rao-Scott) were used to test for cross-sectional differences between waves. Supplementary analyses were performed on the subsample with approximately equalized age ranges across waves.

Results

Prevalence

Figure 1 shows trends in P30D ENDS use and cigarette smoking from 2017 (Wave 4) through 2020 (Wave 5.5). P30D ENDS use increased from 2017 through 2019 (Wave 5; $p < .0001$ for each consecutive pair of waves), at which point it peaked at 8.6%, and subsequently declined by nearly half in just one year to 4.5% (Wave 5.5, 2020, $p < .0001$). Over the same time period, P30D cigarette smoking declined continuously, falling by over 50% between Waves 4 (2017) and 5.5 (2020) and reaching all-time lows of 1.3% in 2020 ($p < .05$ for each consecutive pair of waves).

Device Type

Device type was assessed only in 2019 (Wave 5) and 2020 (Wave 5.5), but there were notable shifts between these two time points. Use of pod-based ENDS declined by over 40% from 54.4% to 31.7% (Figure 2, Table 1; $\chi^2(df = 1) = 43.92$, $p < .0001$). Use of tanks also decreased, 32.5% to 17.4% ($\chi^2(df = 1) = 28.25$, $p < .0001$). Offsetting these declines in pod- and tank-based ENDS was a large shift towards

disposable ENDS: use of disposables was rare in 2019 (5.0% of P30D users), but increased by approximately tenfold to nearly half (49.2%) of P30D users in 2020 ($\chi^2(df=1)=279.61 p<.0001$).

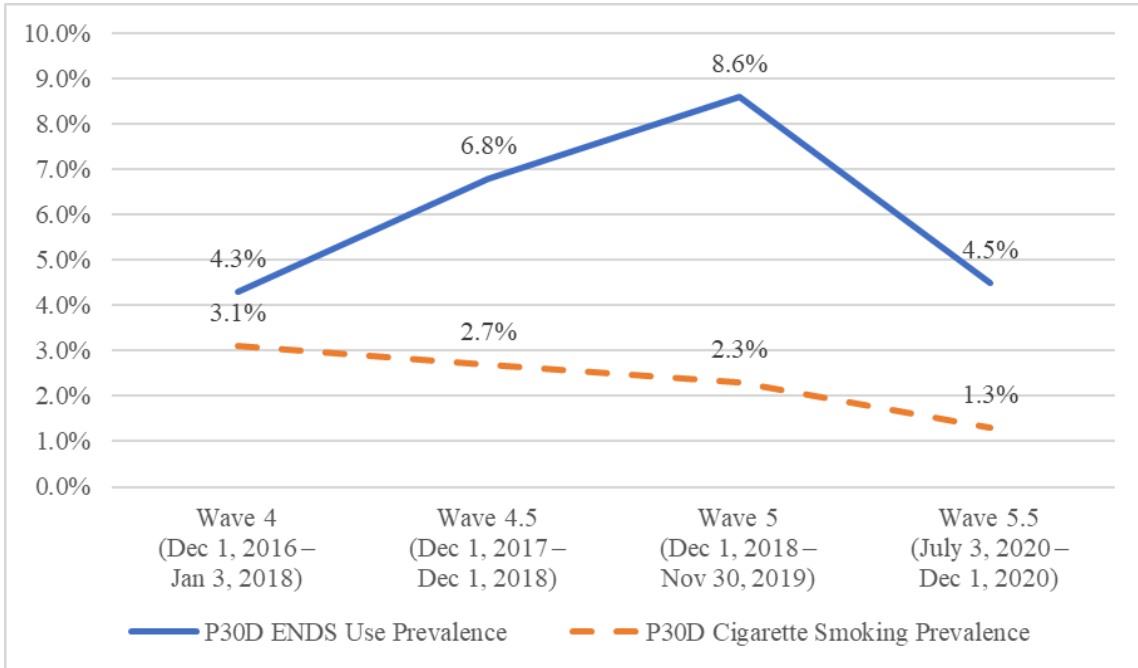


Figure 1. Past 30-Day (P30D) ENDS use and cigarette smoking prevalence, all youth, PATH waves 4 - 5.5.

Note: Wave 5.5 differs from earlier waves because it was administered by telephone (vs. in person as in prior waves) and because the age range is 13-17 years old (vs. 12-17 as in prior waves).

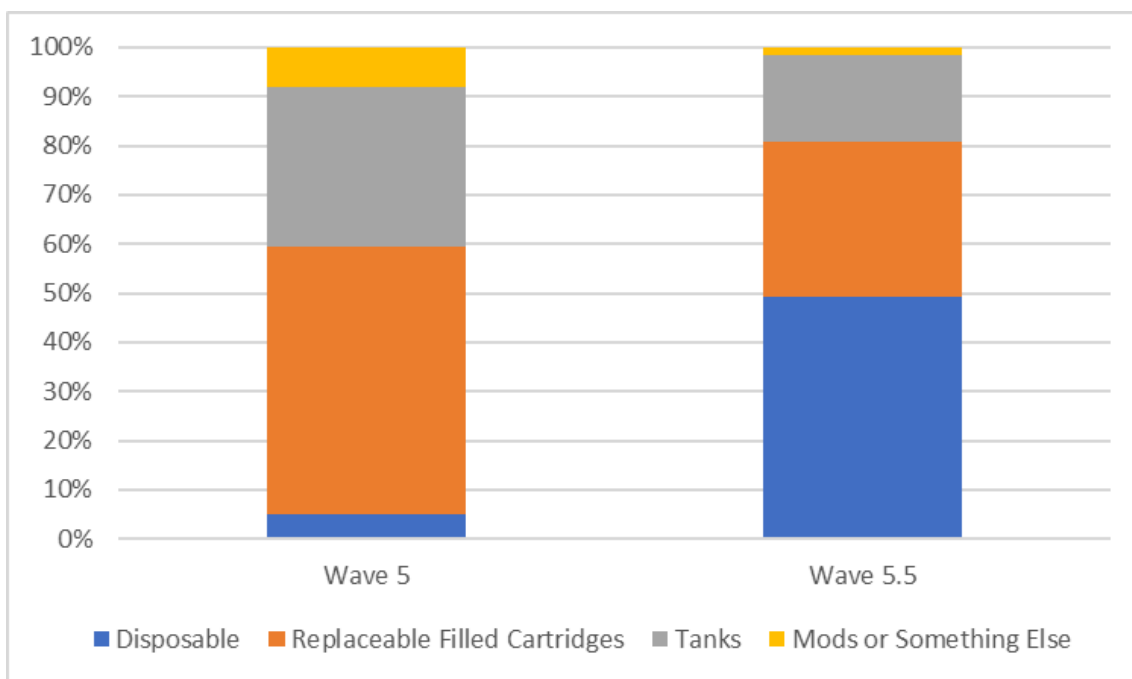


Figure 2. Usual device type among P30D ENDS users, 2019 (Wave 5) and 2020 (Wave 5.5) PATH.

Note: PATH Wave 5.5 differs from earlier waves because it was administered by telephone (vs. in person as in prior waves) and because the age range is 13-17 years old (vs. 12-17 as in prior waves). “Mods” and “something else” were combined due to low endorsement.

Table 1 also shows other patterns of ENDS use, including reported regular/last-used brand, and use of flavors. Brands that appeared in the most common four brands more than once across waves included JUUL, Blu, Smok, E-Swisher, and NJOY; the rank order changed over waves. However, consistent with the shift away from replaceable filled cartridge devices to disposable devices, reporting JUUL as regular/last-used brand declined substantially between 2019 and 2020 (χ^2 (df = 1) = 10.90, $p=.001$), both as a share of P30D use (from 23.9% to 15.3% of P30D users) and in absolute terms (2.1% to 0.7% of all youth (χ^2 (df = 1) = 73.22, $p<.0001$)). JUUL, which had been the most commonly-reported usual brand up to 2019, remained the most common of the explicitly-listed regular/last-used brands in Wave 5.5, but was outweighed by the substantial fraction of youth reporting “some other brand” not explicitly listed, which in 2020 was the most common brand report (31.3% of P30D users, versus 3.2% in 2019). Other common brands in 2020 were Vuse (3.2% of P30D users; 0.1% of youth overall), NJOY (2.4% of P30D users; 0.1% of youth overall), and Smok (1.7% of P30D users; <0.1% of youth overall).

		Wave 4 <i>Dec 1 2016 - Jan 3 2018</i>	Wave 4.5 <i>Dec 1 2017 - Dec 1 2018</i>	Wave 5 <i>Dec 1 2018 - Nov 30 2019</i>	Wave 5.5^a <i>July 3 2020 - Dec 1 2020</i>
Usual device type		Not assessed	Not assessed	Disposable: 5.0% Replaceable filled cartridges: 54.4% Tank that you refill with liquids: 32.5% Mod system/Something else: 8.1%	Disposable: 49.2% Replaceable filled cartridges: 31.7% Tank that you refill with liquids: 17.4% Mod system/Something else: 1.7%
Reported regular/last- used brand	Among all youth	JUUL: 0.2% Some other brand ^b : 0.2% Blu Cigs: <0.1% E-Swisher: <0.1% NJOY: <0.1%† All other brands: 0.2%	JUUL: 0.6% Smok: 0.3% Some other brand ^b : 0.2% Blu Cigs: 0.1% E-Swisher: <.1% All other brands: 0.4%	JUUL: 2.1% Some other brand ^b : 0.3% Blu Cigs: 0.3% Smok: 0.2 E-Swisher: 0.1% All other brands: 0.3%	Some other brand ^b : 1.4% JUUL: 0.7% Vuse: 0.1% NJOY: 0.1% Smok: <0.1%† All other brands: 0.1%
	Among P30D users	JUUL: 4.4% Some other brand ^b : 3.6% Blu Cigs: 1.9% E-Swisher: 1.7% NJOY: 0.8% Don't know brand: 83.8%	JUUL: 9.1% Smok: 4.5% Some other brand ^b : 2.5% Blu Cigs: 2.0% E-Swisher: 1.2% Don't know brand: 75.5%	JUUL: 23.9% Some other brand ^b : 3.2% Blu Cigs: 3.0% Smok: 1.8% E-Swisher: 1.5% Don't know brand: 63.3%	Some other brand ^b : 31.3% JUUL: 15.3% Vuse: 3.2% NJOY: 2.4% Smok: 1.7% Don't know brand: 42.9%

	Wave 4 Dec 1 2016 – Jan 3 2018	Wave 4.5 Dec 1 2017 – Dec 1 2018	Wave 5 Dec 1 2018 – Nov 30 2019	Wave 5.5 ^a July 3 2020 – Dec 1 2020
Flavors^c	Tobacco: 10.3% Menthol/mint: 24.2% Fruit/sweet/other ^d : 90.9%	Tobacco: 11.3% Menthol/mint: 41.6% Fruit/sweet/other ^d : 88.3%	Tobacco: 9.6% Menthol/mint: 54.7% Fruit/sweet/other ^d : 79.4%	Tobacco: 13.3% Menthol/mint: 53.8% Fruit/sweet/other ^d : 74.9%

Table 1. Usual ENDS device type, regular/last-used ENDS brand, and ENDS flavors among P30D ENDS users, PATH Waves 4 – 5.5.

Notes: † Unreliable due to small numbers ($N \leq 5$).

a: PATH Wave 5.5 (2020) differs from prior waves because it was administered by telephone (vs. in person as in prior waves) and because the age range is 13–17 years old (vs. 12–17 as in prior waves).

b: “Some other brand” is a collective category including all other brands that were not explicitly reported in the PATH variable (either as an explicit response option or a recode from write-in responses); see Supplementary Table 2 for full list of response options.

c: Flavors were assessed as select-all-that-apply, and so total to >100%.

d: “Fruit/sweet/other” is a combined category consisting of “fruit,” “candy/dessert/sweets” (a single response in PATH), “chocolate,” “clove/spice,” “alcoholic drink,” “non-alcoholic drink,” and some other flavor not listed.

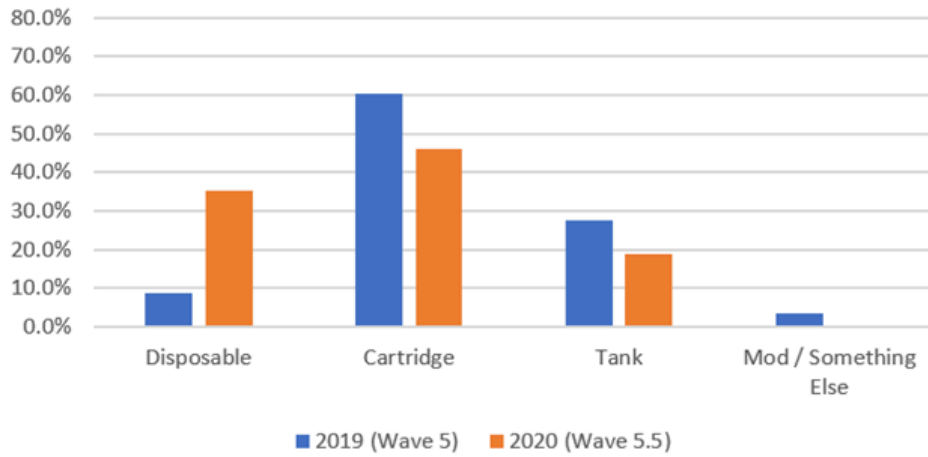
Follow-up analyses examined the correspondence between those selecting “some other brand” and device type, with a particular focus on disposable ENDS, for which the most common brands were not provided as explicit response options (Supplementary Table 1). In 2020, among P30D users who reported a regular/last-used brand, those who usually used disposable devices were more than three times as likely to report “some other brand” than were those who usually used pods (77.9% vs. 18.2%, respectively, $\chi^2(df = 1) = 60.35, p < .0001$), likely as a result of the absence of common disposable brands in the response options.

Of those who usually used a tank, “some other brand” responses were also common (63.6%), though not as common as for disposables. There were not enough respondents using mods or other types of devices for analyzing brand responses.

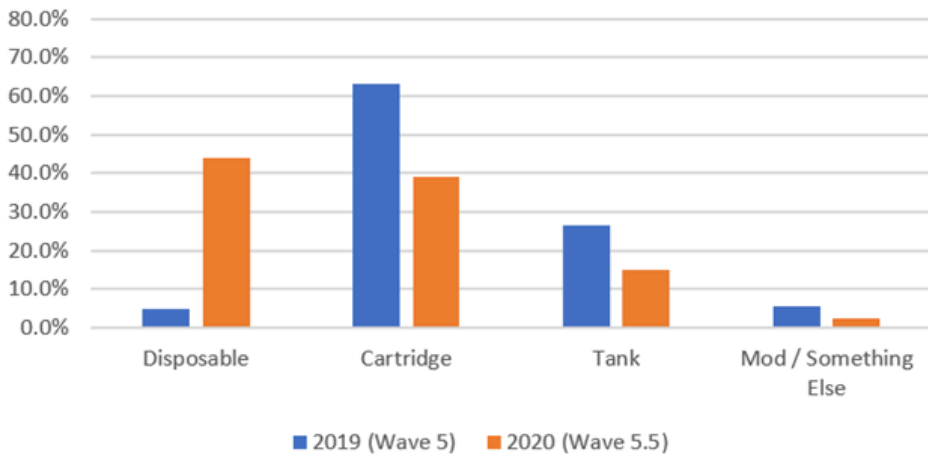
The combination of flavor and device type was examined in 2019 and 2020 (Figure 3). Overall (Table 1), flavored ENDS use declined since 2017 (Wave 4), but remained common and similar in 2019 and 2020 as a proportion of P30D ENDS use, with 74.9% reporting use of fruit/sweet/other flavors in 2020. Fruit was the largest component of this combined category (not shown in table) with approximately 67% of P30D users reporting using fruit-flavored ENDS in both 2019 and 2020. However, accompanying the overall shift in device type towards disposables between 2019 and 2020, those who used fruit/sweet/other flavors shifted to disposable ENDS, by a factor of more than 12 (from 4.4% to 58.4%; $\chi^2(df = 1) = 359.70, p < .001$). Correspondingly, those who used fruit/sweet/other flavors were nearly 60% less likely to have usually used pod/cartridge devices (from 50.0% to 20.9%, $\chi^2(df = 1) = 67.96, p < .001$), and approximately half as likely to have usually used tank devices (from 36.4% to 19.3%; $\chi^2(df = 1) = 29.87, p < .001$).

Additionally, among youth who used tobacco flavor at all in the P30D, their usual device type also shifted towards disposables between 2019 and 2020 (from 8.8% to 35.1%; $\chi^2(df = 1) = 11.59, p < .001$), with concomitant reductions in use of pods/cartridge devices (from 60.3% to 46.0%) and tanks (from 27.4% to 18.9%). Taking into account both the overall decline in pod/cartridge use and the differing device types used by flavor, the absolute number of pod/cartridge users who used tobacco flavor declined by more than half between 2019 and 2020 ($N = 118,622$ [95% CI: 84,222–153,021] to $N = 52,057$ [27,477–76,648], $\chi^2(df = 1) = 5.76, p = .016$), while the number of disposable users who used fruit/sweet/other flavor increased by more than four times ($N = 70,579$ [95% CI: 45,581–95,577] to $N = 371,106$ [295,024–447,188], $\chi^2(df = 1) = 8.44, p = .004$).

Used Tobacco-Flavored ENDS in P30D



Used Mint/Menthol-Flavored ENDS in P30D



Used Fruit/Sweet-Flavored ENDS in P30D

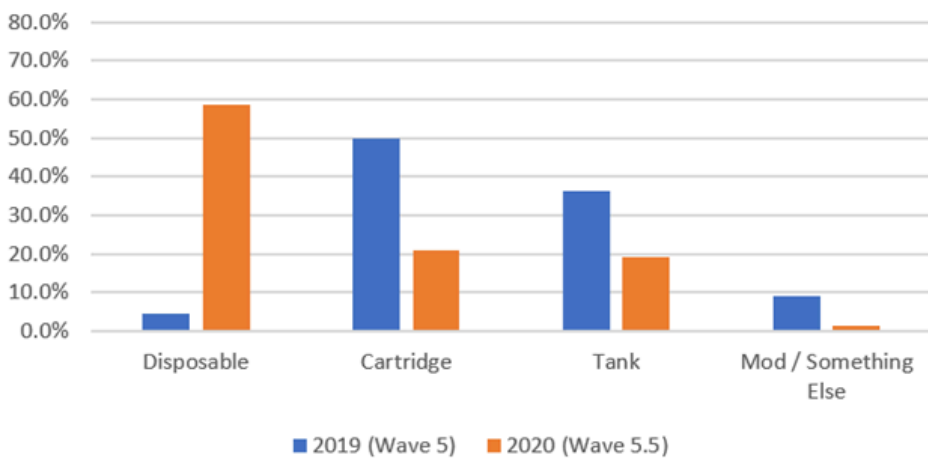


Figure 3: Usual ENDS device type, by use of each flavor category in the past 30 days.

Notes: Flavors may have been used on a device other than their most commonly used device. Flavors were assessed as select-all-that-apply, and so total to >100%; also, respondents may appear in more than one flavor category. The category “fruit/sweet/other” includes response categories of “fruit,” “candy/dessert/sweets” (a single response in PATH), “chocolate,” “clove/spice,” “alcoholic drink,” “non-alcoholic drink”, and some other flavor not listed. PATH Wave 5.5 (2020) differs from prior waves because it was administered by telephone (vs. in person as in prior waves) and because the age range is 13-17 years old (vs. 12-17 as in prior waves).

Supplementary Analyses

Supplementary analyses that approximately equalized the age range across waves show very similar results to the main analyses above. Overall patterns and trends are shown in Supplementary Table 2 and Supplementary Figure 1, respectively; all other analyses showed minimal ($\leq 0.2\%$) difference from the main analysis and are not shown. Results are also highly similar when disaggregating fruit/sweet/other flavors into separate categories (data not shown).

Discussion

This analysis of the most-recently-released PATH data from 2020 (Wave 5.5) showed that youth ENDS use peaked in 2019 and declined by approximately half in 2020, while cigarette smoking declined throughout 2017–2020. There was a large shift towards disposable ENDS, which increased by approximately tenfold between 2019 and 2020. Use of non-tobacco, non-menthol flavors (here, fruit/sweet/other) remained common overall between 2019 and 2020, but the use of these flavors shifted into disposable ENDS (a more than 12-fold increase) and away from pods/cartridges and tanks. Overall, the number of youth using tobacco-flavored ENDS and usually using pod-based ENDS declined by more than half between 2019 and 2020, while the number of youth using fruit/sweet/other-flavored ENDS and usually using disposables more than quadrupled. This is likely to have occurred in response to a FDA’s express prohibition of non-tobacco, non-menthol flavors in pod-based products, while disposable ENDS with flavors other than tobacco or menthol remained in the market notwithstanding their less-certain legal status. Thus, overall, the proportion of ENDS

users using fruit/sweet/other flavors remained relatively constant within the declining number of ENDS users, but youth usage has shifted towards the disposable ENDS in which those flavors were available, consistent with other surveys ^{[5][12][16][21]}.

Corresponding to the shift in the types of ENDS devices used by youth, there was also a shift in the ENDS brands used. There was a substantial decline in the use of JUUL-brand ENDS – a pod-based product – and an increase in those reporting other brands not explicitly queried in the PATH survey, which are likely to be disposable brands. Because commonly-used disposable brands were not explicitly presented as response options in the PATH Wave 5.5 survey, the survey does not allow complete analysis of brands used in 2020, particularly brands of disposable ENDS.

These findings are highly consistent with findings from US other national youth surveys (namely NYTS and MTF) over the same time period. Specifically, both NYTS and MTF show that P30D ENDS use increased over time through its peak in 2019, after which point it substantially declined (by 50% in NYTS 2021, the wave temporally closest to when PATH W5.5 was administered) ^{[3][4][5][6]}. Similarly, other studies show consistent declines in cigarette smoking throughout this time ^{[3][5]}. The declining cigarette smoking during a period of increasing ENDS use can help alleviate concerns that ENDS are a ‘gateway’ or catalyst to smoking. However, given robust evidence that ENDS and cigarettes are economic substitutes for each other ^{[19][24]}, ongoing monitoring is needed to evaluate whether declining ENDS use could have a delayed unintended consequence of increasing cigarette smoking prevalence.

Nevertheless, the majority of youth continued to use fruit/sweet/other-flavored ENDS products in 2020 in spite of the FDA’s enforcement policy aimed at reducing the use of flavors, as youth migrated to products in the marketplace that still had those flavors, consistent with previous research ^{[12][16]}. Specifically, use of pod/cartridge ENDS decreased as use of disposables increased by nearly tenfold in 2020. The changing flavor patterns support this shift as well: while the proportion of P30D users who used fruit/sweet/other flavors remained similar between 2019 and 2020, use of fruit/sweet/other flavors shifted to disposables, and away from pods/cartridges and tanks. The observed shifts expose the results of market conditions that emerged following the FDA’s actions.

Fruit/sweet/other-flavored ENDS use among youth continued to be common, with approximately 75% using these flavors across years and across device types. This was true even in the 2nd half of 2020 (Wave 5.5), when 20.9% of fruit/sweet/other-flavored ENDS reported usually using pod/cartridge

devices – a flavor/device type combination that should have been removed from the market by early 2020. This may refer to the use of flavored products that were different from youths' usual device type; youth were asked about *any* flavored ENDS use, not specifically in their usual brand or device type. The high rates of youth reporting this potential product combination could also reflect product misidentification or the use of illegally-marketed pods, including counterfeits designed to fit compliant devices. The fact that PATH combined mint and menthol flavors is a limitation, as it does not allow for distinction between these two flavors that are regulated differently. Ongoing efforts to reduce the appeal of ENDS products to youth, as well as prevent youth access, are needed.

This shift towards disposable products also occurred more generally in the US, rather than being specific to youth. A shift away from pod-based ENDS to disposable ENDS has also occurred in ENDS sales at the national US level, indicating that adults (who make the majority of sales) have responded similarly to FDA's enforcement against non-tobacco, non-menthol flavored pod-based ENDS [25].

Analyzing regular/last-used brand data in PATH Wave 5.5 requires careful consideration, since the brand identification became problematic with the widespread shift towards disposable products. The finding that the most common regular/last-used brand is "some other brand" not listed likely reflects disposable brand use, since common disposable brands identified in other national youth surveys (e.g. Puff Bar, [12][16]) were not on the list of brands queried by PATH in Wave 5.5. This explanation is corroborated by the fact that a large majority of youth who usually use disposable devices reported regularly or most recently using "some other brand," while this was uncommon in youth who usually used a different device type. Thus, PATH Wave 5.5 brand data is of limited use, and potentially misleading, in that it is relevant only to device types used by a minority of P30D users.

Limitations of the current study include the comparatively delayed nature of PATH relative to other US national surveys (by approximately 2 years), making it impossible at this time to use PATH data to evaluate trends in youth ENDS use in 2021-22. Additionally, PATH prevalence estimates historically differ from those of NYTS and MTF (e.g., ~8.6% ENDS use prevalence in PATH in 2019 [11] vs. ~20.0% in NYTS [17] and 22.5% in MTF [18]). However, reconciling these differences is beyond the scope of this study; instead, we evaluated overall trends, which are consistent with NYTS and MTF. PATH Wave 5.5 differs from previous waves in terms of survey administration changes (i.e. by telephone survey instead of in person) due to COVID-19; it is unclear how this may impact comparability across years, but it may have biased prevalence estimates downward (e.g. NYTS reported that online respondents reported lower tobacco use prevalence than in-person respondents, [26]). In addition to survey

administration changes, COVID-19 itself may have impacted youth tobacco use, for example due to reduced availability during lockdowns and social distancing ^[27], more parental supervision ^[28], less social interaction with peers, and heightened risk perceptions ^[29].

Conclusions

The recently-released PATH Wave 5.5 is consistent with other national youth surveys (namely NYTS and MTF) in showing that ENDS use peaked in 2019 and subsequently declined, and that between 2019 and 2020, youth shifted away from pod/cartridge-based devices – in which non-tobacco, non-menthol flavors were expressly banned in February 2020 – towards disposable devices, in which flavors continued to be available, and in which use of fruit/sweet/other flavors predominates, notwithstanding their less-certain legal status. This shift also caused a shift in usual brand that is not fully captured in PATH Wave 5.5 brand data, suggesting caution in interpreting those brand data.

Disclosures

The preparation of this manuscript was supported by Juul Labs, Inc. Through PinneyAssociates, authors AS, SS, and MH provide consulting services on tobacco harm reduction to Juul Labs, Inc.

Acknowledgements

The authors would like to thank Jonah Joselow of Juul Labs, Inc., for his assistance in determining device types of different ENDS brands queried in PATH.

Footnotes

¹ Sales of all non-tobacco, non-menthol flavors except mint (Mango, Creme, Fruit, and Cucumber) were suspended from retail stores in the US starting in November 2018; online sales of these flavors were also suspended in October 2019. Mint sales were suspended in November 2019.

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Supplementary data: available at <https://doi.org/10.32388/B61CCB>

Declarations

Funding: The preparation of this manuscript was supported by Juul Labs, Inc.

Potential competing interests: The preparation of this manuscript was supported by Juul Labs, Inc. Through PinneyAssociates, authors AS, SS, and MH provide consulting services on tobacco harm reduction to Juul Labs, Inc.