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# Examining associations of e-cigarette flavour restrictions with e-cigarette use and success quitting smoking among US adults

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## ABSTRACT

**Introduction** Restricting available e-cigarette flavours to only tobacco and menthol may reduce appeal among youth; it is unknown how flavour restrictions impact adults using e-cigarettes to quit smoking cigarettes.

**Methods** Online US survey data were collected in summer 2021 from 857 adults who reported using e-cigarettes in a recent attempt to quit smoking. Survey items assessed e-cigarette flavours used during their quit attempt, whether e-cigarette flavour bans restricted access to flavours they like, and what impact the restrictions had on e-cigarette behaviour. Multivariable logistic regression models were used to examine the associations of flavour bans with success quitting smoking for 1 month or longer.

**Results** 30.2% (N=259) reported restricted access to e-cigarette flavours they like. During their quit attempt, 64.9% (N=168) used tobacco or menthol-flavoured e-cigarettes, and 90.7% (N=235) used another flavour that could be affected by restrictions, most commonly fruit, mint, and candy/dessert. Responses to flavour restrictions included switching devices to continue using preferred flavours (39.4%), using the same device only with available flavours (35.9%), buying preferred flavours elsewhere (eg, online) (19.3%), making flavours (3.5%) and 'other' (eg, no longer using e-cigarettes) (1.9%). The odds of quitting smoking for 1 month or longer were not significantly different between those experiencing flavour restrictions (vs not), preferring tobacco/menthol (vs restricted) flavour, or switching flavours in response to the bans (vs finding another way to obtain restricted flavours) ( $p>0.11$ ).

**Conclusion** Experiencing e-cigarette flavour restrictions was not associated with success quitting smoking among adults using e-cigarettes to try to quit.

## INTRODUCTION

The availability of flavoured e-cigarettes is an important scientific and public health debate. Flavoured e-cigarettes may benefit public health if they facilitate switching from smoking to exclusive e-cigarette use.<sup>1,2</sup> However, flavoured e-cigarettes appeal to youth, with flavours often cited as a top reason for youth use.<sup>3-5</sup> Several countries worldwide have restricted flavoured tobacco products,<sup>6,7</sup> including some that limit flavoured e-cigarettes in an effort to reduce appeal to youth,<sup>8</sup> yet it is unknown whether e-cigarette flavour restrictions are associated with quitting smoking among adults using e-cigarettes to quit. Thus, the goal of the present study was to survey the effects of flavour restrictions among a sample of US adults who reported using e-cigarettes to quit smoking. Study aims included evaluating associations of e-cigarette flavours used

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ E-cigarettes may benefit public health if they facilitate switching from smoking to exclusive e-cigarette use. Regulations that restrict available e-cigarette flavours aim to reduce appeal among youth, yet it is unknown how flavour restrictions impact adults using e-cigarettes to quit smoking.

## WHAT THIS STUDY ADDS

⇒ This study is the first to assess associations of e-cigarette flavour restrictions with e-cigarette behaviour and success quitting smoking among a sample of adults who used e-cigarettes in a recent attempt to quit smoking.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

⇒ Our results suggest that regulations restricting e-cigarette flavours were not associated with smoking cessation success among adults using e-cigarettes to quit smoking and may inform future research and e-cigarette policy.

when trying to quit smoking and responses to e-cigarette restrictions with duration of smoking abstinence achieved.

## METHODS

### Participants and procedures

All procedures were approved by the Yale University Institutional Review Board. We recruited participants across the USA for an online, anonymous 20-minute survey through Qualtrics Online Sample. Qualtrics recruited participants directly via emails to registered panellists who were likely to be eligible (eg, based on smoking history), and those who were eligible and completed the survey were compensated by Qualtrics. Eligibility included living in the USA, age  $\geq 21$  years, reporting a history of regular cigarette smoking (ie, smoking  $\geq 1$  year,  $\geq 4$  days/week) and reporting using e-cigarettes when trying to quit smoking in the past 2 years.

From May to July 2021, 857 participants completed the survey. Quotas were set to ensure diversity by sex (approximately 50% female/50% male), ethnicity/race (at least 35% minority) and region of the country (Northeast, South, Midwest, West). A final quota was set to ensure roughly equal numbers of participants who stopped smoking  $\geq 1$  month versus  $< 1$  month when using e-cigarettes to try to quit.



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**Table 1** Logistic regression results examining the effects of e-cigarette flavour bans and flavours used during a smoking cessation attempt on success quitting for 1 month or longer

	N (%)	Success quitting for 1 month or longer (vs quitting for less than 1 month)	
		OR (95% CI)	AOR* (95% CI)
(1) Experienced e-cigarette flavour bans (vs no)	259 (30.2)	1.31 (0.98 to 1.76)	1.18 (0.87 to 1.60)
(2) Restriction impact: switched flavours (vs finding another way to continue using restricted flavours)†	93 (35.9)	1.18 (0.71 to 1.96)	1.52 (0.85 to 2.69)
(3) Used tobacco/menthol e-cigarette flavour when quitting‡ (vs no)	168 (64.9)	0.72 (0.43 to 1.20)	0.65 (0.38 to 1.11)
(4) Used flavour other than tobacco/menthol when quitting‡ (vs no)	235 (90.7)	1.30 (0.56 to 3.02)	1.07 (0.44 to 2.65)
(5) Preferred tobacco/menthol e-cigarette flavour when quitting‡ (vs other)	84 (32.4)	0.90 (0.54 to 1.52)	0.94 (0.55 to 1.61)

CIs that do not include 1.00 indicate statistical significance,  $p < 0.05$ . N (%) presents descriptive data among the entire sample (1) and among the subsample who experienced a flavour restriction (2–5).  
 \*Adjusted for demographic covariates of age, sex, region, race/ethnicity, education, financial status. Results were consistent with or without tobacco history covariates (cigarettes per day, number of years smoked).  
 †Responses to flavour restrictions were coded as switching flavours ('using the same device but only with available flavours') versus finding another way to continue using restricted flavours ('switching devices to continue using preferred flavours', 'buying elsewhere to obtain preferred flavours', 'making one's own flavours'). N=5 who selected 'other' were not included in this analysis.  
 ‡Sensitivity analyses examined e-cigarette flavour coded as tobacco versus other and tobacco or menthol versus other, since menthol flavour is restricted in some locations, and results were consistent.  
 AOR, adjusted OR; CI, confidence interval; OR, odds ratio.

## Measures

### Demographics

Participants reported age, sex (female/male), Hispanic identity (no/yes), race (white, Black/African American, Asian, Native American, Pacific Islander/Native Hawaiian, Other (select all that apply)), highest education achieved (less than high school to professional degree) and subjective financial situation (eg, 'I do not meet basic expenses').<sup>9</sup>

### E-cigarette use during a recent quit attempt

Participants reported if they had attempted to quit smoking in the past 2 years and, if so, selected methods used during the quit attempt. Those endorsing using e-cigarettes during their quit attempt were eligible to continue the survey.

### E-cigarette flavours used during a quit attempt

Participants reported e-cigarette flavours used during their quit attempt from a list with flavour examples provided (select all that apply): tobacco, menthol, mint (eg, spearmint, wintergreen, peppermint), fruit (eg, cherry), candy or dessert (eg, chocolate), vanilla, coffee (eg, cappuccino), spice (eg, clove), alcohol (eg, piña colada), other beverage (eg, soda), other (write in). Participants also indicated their single most preferred e-cigarette flavour when trying to quit smoking.

### Flavour restrictions

Participants reported whether bans on certain flavours where they live made it difficult or impossible to get the e-liquid/pod flavours that they liked (yes/no).

### Impact of flavour restrictions on e-cigarette use

Participants who endorsed experiencing flavour restrictions subsequently responded to 'how did you deal with the flavour restrictions' (select all that apply: 'I switched devices so that I could use flavours I liked', 'I continued to use my same device but only used flavours that were available', 'I made my own flavours', 'I bought flavours online or from other places where the flavours I liked were allowed', 'other' (write in)).

### Duration of smoking abstinence during the quit attempt

Participants reported the longest amount of time during the past 2 years they went without smoking specifically because

they were using e-cigarettes to try to quit (less than a day, less than a week, 1–3 weeks, 1 month, 2–3 months, 4–6 months, 7–9 months, 10–12 months, more than a year). We categorised participants as having a successful (quit  $\geq 1$  month) or unsuccessful (quit  $< 1$  month) quit attempt.

### Tobacco use history

Participants reported smoking characteristics based on their current use pattern (if they were currently smoking) or based on their historical use pattern (if they recently quit). Smoking history characteristics included the average number of cigarettes smoked per day and number of years smoked.

### Data analysis

We used descriptive statistics to characterise the percentage of the sample reporting that flavour bans restricted access to e-cigarette flavours they like. Among the subsample who experienced flavour restrictions, we examined the frequency of reported e-cigarette flavours used during the quit attempt and the reported response to the flavour restrictions. Multivariable logistic regression models were used to examine the association of flavour bans with success quitting smoking (yes vs no). Separate models were conducted among the entire sample (N=857) to examine the extent to which experiencing a flavour ban (yes vs no) was associated with success quitting smoking, and among the subsample who experienced a flavour ban (N=259) to examine the extent to which e-cigarette flavours used or preferred when quitting or the response to the flavour ban were associated with success quitting smoking. No data were missing. These models included demographic covariates (age, sex, race/ethnicity, US region, socioeconomic status, education). Sensitivity analyses examined e-cigarette flavour coded as tobacco versus other and tobacco or menthol versus other, since menthol flavour is restricted in some locations,<sup>10</sup> and results were consistent.

## RESULTS

### Participants

Participants were 40.8 years old on average (SD=12.3), 47.6% female, with a history of smoking for 17.5 years (SD=12.7) and 11.5 cigarettes per day (SD=7.6). In terms of race/ethnicity, 21.7% identified as Hispanic, 62.8% non-Hispanic (NH) white, 7.7% NH black and 7.8% NH other. Regarding education, 19.3% had a high school degree/GED (General Education Development) or less,

34.5% attended some college, 28.5% had a bachelor's degree and 17.7% had an advanced degree. In terms of income, 7.2% did not meet basic needs, 23.2% just met basic needs, 27.7% met needs with a little left over and 41.9% reported living comfortably.

### E-cigarette flavour restriction and impact

Among the full sample, 30.2% (N=259) reported restricted access to e-cigarette flavours they like. Among those who experienced flavour restrictions, 64.9% reported using tobacco or menthol flavours during their quit attempt, and 90.7% used another flavour that could have been restricted; the most common were fruit (54.1%), mint (43.6%) and candy/dessert (39.0%). The most common preferred flavours to use when quitting were fruit (29.7%), menthol (19.7%), mint (13.9%), tobacco (12.7%) and candy/dessert (7.3%). Responses to flavour restrictions included switching devices to continue using preferred flavours (39.4%), using the same device with available flavours (35.9%), buying elsewhere (eg, online) to obtain preferred flavours (19.3%), making one's own flavours (3.5%) and 'other' (eg, no longer using e-cigarettes) (1.9%).

In multivariable models, experiencing e-cigarette flavour bans (yes/no), e-cigarette flavours used or preferred when quitting, or switching e-cigarette flavours in response to the bans (vs finding another way to obtain restricted flavours) were not significantly associated with success quitting smoking for 1 month or longer. Results were consistent across unadjusted and adjusted models (table 1).

### DISCUSSION

This study is the first to assess associations of e-cigarette flavour restrictions with e-cigarette behaviour and success quitting smoking among a sample of adults who used e-cigarettes in a recent attempt to quit smoking. Understanding the role of e-cigarette flavours in supporting smoking cessation among adults is important for informing tobacco regulations, especially as various countries enact other restrictions on flavoured tobacco products.<sup>6</sup>

While 30% of adults experienced e-cigarette flavour restrictions that made it difficult to obtain flavours they liked, most found alternative ways to obtain restricted flavours (eg, switching devices, buying elsewhere). Importantly, the odds of quitting smoking for 1 month or longer were not significantly different between those experiencing flavour restrictions (vs not), preferring tobacco/menthol (vs restricted) flavour, or switching flavours in response to the bans (vs finding another way to obtain restricted flavours). Thus, while adults reported that e-cigarette flavour restrictions altered their e-cigarette use behaviour, these restrictions were not associated with success using e-cigarettes to quit smoking.

Study limitations must be considered. First, use of US panel members may limit generalisability, and replication with larger, diverse populations is warranted. Second, self-reported outcomes may be impacted by recall bias. Third, smoking outcomes were not biochemically confirmed. Fourth, the study was cross-sectional and given the survey design, we were unable to differentiate the e-cigarette flavours used before versus after e-cigarette restrictions, and longitudinal research is needed to clarify the potential impact of specific e-cigarette flavour restrictions. Furthermore, flavour restrictions may differ based on location (eg, state, city) or device used (eg, closed cartridge systems<sup>8</sup>). Therefore, a strength of our approach is assessing whether flavour restrictions were experienced on an individual level and how e-cigarette behaviour changed. The study findings provide new information that may help inform future research to advance e-cigarette policy. While adults who use

e-cigarettes to quit smoking may prefer using flavours other than tobacco or menthol (eg, fruit), if studies indicate the availability of these flavour(s) does not affect smoking cessation outcomes, this may strengthen the rationale for restricting flavours that are especially appealing to youth.

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**Competing interests** Outside of the submitted work, SO reports being a member of the American Society of Clinical Psychopharmacology's (ASCP) Alcohol Clinical Trials Initiative, supported by Alkermes, Dicerna, Ethypharm, Lundbeck, Mitsubishi Tanabe, Otsuka; consultant/advisory board member, Alkermes, Dicerna, Opiant; medication supplies, Novartis; DSMB member for NIDA Clinical Trials Network, Emmes Corporation; and has been involved in a patent application with Novartis and Yale. The other authors have no disclosures to report.

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**Ethics approval** This study involves human participants and was approved by the Yale University Institutional Review Board (protocol #2000028926). Participants gave informed consent to participate in the study before taking part.

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### REFERENCES

- Goniewicz ML, Gawron M, Smith DM, *et al.* Exposure to nicotine and selected toxicants in cigarette smokers who switched to electronic cigarettes: a longitudinal within-subjects observational study. *Nicotine Tob Res* 2017;19:160–7.
- Hartmann-Boyce J, McRobbie H, Butler AR. Electronic cigarettes for smoking cessation. *CDSR* 2021.
- USDHHS. E-cigarette use among youth and young adults. A report of the Surgeon General. In: *U.S. Department of Health and Human Services; Centers for Disease Control and Prevention; National Center for Chronic Disease Prevention and Health Promotion; Office on Smoking and Health*. Atlanta, GA, 2016.
- Wang TW, Gentzke AS, Creamer MR, *et al.* Tobacco Product Use and Associated Factors Among Middle and High School Students — United States, 2019. *MMWR Surveill. Summ.* 2019;68:1–22.
- Cullen KA, Gentzke AS, Sawdey MD, *et al.* E-Cigarette use among youth in the United States, 2019. *JAMA* 2019;322:2095–103.
- Erinosa O, Clegg Smith K, Iacobelli M, *et al.* Global review of tobacco product flavour policies. *Tob Control* 2021;30:373–9.
- Chaiton MO, Cunningham R, Hagen L. Taking global leadership in banning menthol and other flavours in tobacco: Canada's experience. *BMJ* 2022;31:202–11.
- FDA. *FDA finalizes enforcement policy on unauthorized flavored cartridge-based e-cigarettes that appeal to children, including fruit and mint*, 2020.
- Williams VF, Smith AA, Villanti AC, *et al.* Validity of a subjective financial situation measure to assess socioeconomic status in US young adults. *J Public Health Manag Pract* 2017;23:487–95.
- Campaign for Tobacco Free Kids. States and localities that have restricted the sale of flavored tobacco products, 2022. Available: <https://www.tobaccofreekids.org/assets/factsheets/0398.pdf>