HHS Public Access

Author manuscript

Tob Control. Author manuscript; available in PMC 2023 January 01.

Published in final edited form as:

Tob Control. 2023 January ; 32(1): 114–117. doi:10.1136/tobaccocontrol-2020-056416.

"Ice" Flavored e-Cigarette Use among Young Adults

Adam M. Leventhal, Ph.D.[a], **Hongying Dai, Ph.D.**[b], **Jessica L. Barrington-Trimis, Ph.D.**[a], **Steve Sussman, Ph.D.**[a]

[a]department of Preventive Medicine, University of Southern California Keck School of Medicine, 2001 N Soto Street, 302-C, Los Angeles, CA 90089

[b]Department of Biostatistics, College of Public Health, University of Nebraska Medical Center, Omaha, NE, 68198-4355

Abstract

Background ——"Ice" e-cigarette flavors – marketed as a combination of fruity/sweet and cooling flavors (e.g., "blueberry ice" or "melon ice") – recently entered the U.S. market. The prevalence and correlates of ice flavored e-cigarette use in young adults are unknown.

Methods ——This cross-sectional study of a Los Angeles, CA, USA cohort analyzed data from past 30-day e-cigarette (current) users (n=344; M[SD]=21.2[0.4] years old) who completed web-based surveys from May-August 2020. The exposure variable was self-reported e-cigarette flavor used most often in the past month (menthol/mint, fruit/sweet, or ice). Outcomes included self-reported combustible tobacco use, vaping dependence symptoms, frequency of use, and device type used.

Results ——Among current e-cigarette users, 48.8% reported using ice flavors most often, 33.7% predominately used fruit/sweet, and 17.4% used menthol/mint. Using primarily ice-flavor was associated with reporting more past-30-day vaping days (vs. menthol/mint: b=4.4,95%CI[1.0-7.7]; vs. fruit/sweet: b=3.6,95%CI[0.8-6.4]) and more episodes per vaping day vs. fruit/sweet users (b=2.4,95%CI[0.5-4.3]). Ice-flavor users were less likely than menthol/mint users to use JUUL/cartridge-based rechargeable (OR=0.1,95%CI[0.03-0.45]) and more likely than sweet/fruit users to use disposable non-cartridge (OR=3.9,95%CI[2.1-7.4]) devices than refillable/rechargeable tank/pen or other devices. Ice users had greater odds of past 30-day combustible tobacco use vs. menthol/mint users (OR=2.7,95%CI[1.3-5.7) and vaping dependence symptoms than vs. sweet/fruit users (OR=2.6, 95%CI[1.5-4.4]).

Corresponding author: Adam Leventhal, Institute for Addiction Science, 2250 Alcazar St, CSC 240, Los Angeles, CA 90033. Tel 323-442-8222. adam.leventhal@usc.edu.

Disclosures: The authors report no potential conflicts of interests

Access to Data and Data Analysis: Dai had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Leventhal, Dai.

Acquisition, analysis, or interpretation of data: Leventhal, Dai, Barrington-Trimis, Sussman.

Drafting of the manuscript: Leventhal, Dai.

Critical revision of the manuscript for important intellectual content: Leventhal, Dai, Barrington-Trimis, Sussman.

Statistical analysis: Dai

Obtained funding: Leventhal

Conclusion ——Young adult use of ice flavored e-cigarettes may be common and positively associated with combustible tobacco use, nicotine vaping frequency and dependence, and use of disposable e-cigarette devices. Further study of the prevalence, determinants and health effects of ice flavored e-cigarette use is warranted.

Keywords

e-cigarette; flavor; ice flavors; menthol or mint; fruit or sweet flavor; young adult

E-cigarette use (vaping) is common and associated with adverse health effects in U.S. young adults.[1, 2] Availability of appealing flavors has been cited by young adults as one of the top reasons they use e-cigarettes.[3] Studying the prevalence and correlates of specific e-cigarette flavors used among young adults is important for informing policy affecting young adult health.

Until recently, most prominent non-tobacco e-cigarette flavors fell into two mutually-exclusive classes—those with either sweet (e.g., fruit, dessert) or cooling (e.g., menthol, mint) attributes.[4] In the context of recent regulations on flavored e-cigarette products that exempted menthol products [5] and rapidly evolving e-cigarette markets, “ice” e-cigarette flavors recently entered the marketplace in conjunction with a surge of disposable e-cigarette sales.[6] “Ice”-flavored e-cigarettes are marketed as possessing both sweet and cooling properties in fruit/dessert-cooling combinations (e.g., “blueberry ice” or “melon ice”). They may not fit into existing flavoring categorizations, which may complicate regulatory action. The prevalence and tobacco-related correlates of ice flavored e-cigarette use among young adults are unknown.

This cross-sectional self-report study compared young adults that predominately used e-cigarettes in ice flavors to those that predominately used either menthol/mint or fruit/sweet flavors. Flavor preference groups were compared on tobacco product use characteristics of importance to public health and regulatory policy (e.g., combustible tobacco use and vaping dependence, frequency of use, device type used).

Methods

Participants and Measures

Data were drawn from the Happiness & Health Study—a prospective cohort study of health behavior which originally recruited 9th grade students in Los Angeles, CA, USA schools in 2013 (n=3396).[7] Students provided informed consent, and this study included participants who completed the most recent web-based survey (May 18-August 3, 2020) as young adults (N=2179).

Of 407 past 30-day e-cigarette users, 383 responded to the question “How would you best describe the types of flavors you use most often?” with 8 forced-choice responses. Due to small cells, we excluded participants reporting “flavorless” (n=13), “tobacco flavored” (n=5), “non-sweet (e.g., alcohol, spice)” (n=1), and “mix of flavors” (n=20). In the remaining analytic sample (n=344), the exposure variable contained three mutually-exclusive groups: 1) a combination of “menthol/mint”; 2) “fruit/sweet”; and 3) “ice-fruit

combinations". Appendix Figure 1 depicts participant accrual and inclusion in the analytic sample.

The following tobacco product use characteristics were outcome variables: 1) past 30-day combustible tobacco use; 2) past 30-day vaping device type used most often (response categories in Table 1); 3) vaping dependence measured by the modified Hooked on Nicotine Checklist (≥1 vs. 0 symptoms);[8, 9] 4) quit attempts defined as 'stopped vaping for ≥1 days' in the past 6 months (yes/no); 5) vaping during vs. after high school; 6) past 30-day number of days vaped (continuous, range:1–30);[10] 7) past 30-day number of nicotine vaping episodes per vaping day (continuous, range:1–20);[10] and 8) past 30-day number of puffs per nicotine vaping episode (continuous, range:1–20).[10]

Covariates included age, gender, race/ethnicity, post-high school, living with parents, personal financial situation, and sexual minority status. See Appendix Table 1. Participants were also asked which flavor they used when they first tried vaping nicotine.

Statistical Analyses

Associations of e-cigarette flavor used most often with tobacco product use characteristics were estimated in logistic (dichotomous outcomes) or linear (continuous outcomes) multivariable regression models including all covariates, yielding odds ratios (ORs) or regression weights (bs) with 95% CIs, respectively. Planned pairwise tests compared ice to the two other flavor categories. Complete exposure and outcome variable data were required to be included in analyses. Missing covariate data were infrequent (n range: 0–15) and managed with multiple imputation using 20 multiply-imputed data sets.[11] Statistical significance was P<.05(2-tailed).

Results

The analytic sample (n=344; age, M[SD]=21.2[0.4] years; 54.1% female) was sociodemographically diverse (Race/ethnicity: Hispanic=40.5%, Asian=19.3%, non-Hispanic White= 19.6%, non-Hispanic Black=3.6%, Other=17.0%; and 24.9% sexual minority). Sociodemographic covariates did not significantly differ by e-cigarette flavor used except for gender and race/ethnicity (see Appendix Table 1).

Overall, 168 (48.8%) reported most often using ice flavors, 60 (17.4%) menthol/mint, and 116 (33.7%) fruit/sweet. In comparison to menthol/mint flavored e-cigarette users, ice flavor users were more likely to report past-30-day combustible tobacco use (31.5% vs. 21.7%, Adjusted-OR =2.7,95%CI[1.3–5.7]). Ice flavor users were less likely than menthol/mint flavor users to report using JUUL/similar cartridge rechargeable vs. refillable/rechargeable tank/pen or other e-cigarette (3.5 vs. 23.5%, Adjusted-OR =0.1,95%CI[0.03–0.45]) devices and more likely than fruit/sweet flavor users to use disposable non-cartridge vs. refillable/rechargeable or other (65.3% vs. 34.7%,Adjusted-OR =3.9,95%CI[2.1–7.4]) devices. Ice vs. fruit/sweet flavor users were more likely to report vaping dependence symptoms (67.1% vs. 43.0%, Adjusted-OR =2.6,95%CI[1.5–4.4]), starting vaping during high school (73.9% vs. 65.1%,Adjusted-OR =1.9,95%CI[1.0–3.4]), and more vaping episodes per day (Mean[SD]=10.8[7.9] vs. 7.6[8.1], Adjusted-b=2.4,95%CI[0.5–4.3]).

Ice flavor users also reported more past-30-day vaping days (Mean[SD]=17.0[11.5]) than fruit/sweet (Mean[SD]=12.1[11.8],Adjusted-b=3.6,95%CI[0.8–6.4]) or menthol/mint (Mean[SD]=12.2[11.2], Adjusted-b=4.4,95%CI[1.0–7.7]) flavor users. Other comparisons were non-significant (Table).

Among the 168 current ice flavor users, 43 (25.6%) used menthol/mint-flavored e-cigarettes initially, 56 (33.3%) and 69 (41.1%) began with fruit/sweet and ice flavors, respectively. Of those that vaped ice flavors during initial use, 84.1% currently used ice flavors most often (Appendix Table 2).

Discussion

In this young adult cohort from Los Angeles, CA, USA in 2020, ice was the most common e-cigarette flavor used. Recent nationally representative studies find that most U.S. young adults use either fruit or mint/menthol-flavored e-cigarettes.[12] The supplemental analysis also suggested that most ice flavor users migrated from initially vaping other flavors.

Young adults who predominately used ice flavored e-cigarettes in this study exhibited a profile of increased combustible tobacco product use and more frequent, heavy, and dependent vaping in comparison to one or both other groups that used non-ice flavors. While causality cannot be inferred from this cross-sectional study, it is possible that exposure to e-cigarettes in ice flavors may somehow increase nicotine vaping frequency and dependence. Previous clinical laboratory studies show that fruit and menthol flavors each independently increase the appeal of e-cigarettes and suppress the aversive qualities of nicotine in young adults by creating perceptions of sweetness and coolness, respectively.[4, 13, 14] Flavors that increase the palatability of high-concentration e-cigarettes could play a role in combustible tobacco product use, given evidence that vaping higher nicotine concentration is associated with subsequent increased combustible tobacco use in young people.[10] If flavors with both sweet and cooling sensory attributes additively increase the appeal of nicotine vaping, it is plausible that fruit-cooling combinations in ice flavors (vs. fruit-only or mint/menthol-only flavors) could incrementally increase risk for frequent vaping, nicotine dependence, and poly-tobacco product use. Alternatively, more frequent and chronic vapers or smokers could be drawn to ice flavors. In this study, ice flavor users were more likely to have started vaping in high school than fruit/sweet flavor users and therefore had longer vaping histories, which could allow more time to migrate toward ice flavors.

In comparison with fruit/sweet flavor users, ice flavor users were more likely to report using disposable versus refillable devices. Disposable e-cigarettes are among the fastest-growing segments of the e-cigarette market, exemplified by the Puff Bar brand,[6] raising questions as to the role of ice flavors in the appeal of disposable products. JUUL, the most widely-sold U.S. e-cigarette brand in 2019,[15] stopped selling non-tobacco flavors except menthol in late 2019. The U.S. issued guidance to clear cartridge-based e-cigarettes non-tobacco flavors other than menthol in February 2020.[5] In the context of such changes, the current finding that menthol/mint users were more likely to use JUUL or other cartridge-based devices than ice flavor users may reflect a concentration of sales of menthol and limited availability of ice flavor in these products. By contrast, some disposable e-cigarette makers might still have

been marketing ice flavors in 2020 while awaiting enforcement of U.S. FDA issued warning letters to stop selling flavored disposable e-cigarettes by July 2020.[16] Puff Bar markets its product as containing “tobacco-free nicotine,” raising uncertainty as to whether they are subject to these and other U.S. tobacco product regulations.[17] Future studies should assess how the evolving regulatory context may impact use of ice-flavored e-cigarettes.

This study has limitations. First, all measures were self-reported and subject to recall error. As ice flavors are new in the market, optimal methods and response option labels for identifying self-reported ice flavor use worth additional research. Second, past-month number of vaping days measure did not distinguish between participants using nicotine-containing and nicotine-free e-cigarettes. Third, some cell sizes were small, which may have produced insufficient statistical power and precluded inclusion of participants that predominantly used other flavors (e.g., tobacco, flavorless, non-sweet). Finally, nicotine concentration was not assessed in this study, which merits future research.

Conclusion

Young adult use of ice flavored e-cigarettes may be common and positively associated with combustible tobacco use, nicotine vaping frequency and dependence, and use of disposable e-cigarette devices. Because ice flavors represent a hybrid that may contain both cooling and fruity flavoring constituents, it is unclear how these flavors fit into current and future regulatory policies that place differential restrictions across different flavor categories. Further studies of the specific cooling agents and chemical constituents in ice flavored products and health effects of ice flavored e-cigarette use are warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

Funding: Research reported in this publication was supported by the National Cancer Institute under Award Number U54CA180905 (Leventhal/Pentz) and by the National Institute on Drug Abuse Award Number K24DA048160 (Leventhal). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Role of Funder:

The funding agency had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

References

[1]. U.S. Department of Health and Human Services. E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General. Atlanta: US 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 2016.

[2]. Dai H, Leventhal AM. Prevalence of e-Cigarette Use Among Adults in the United States, 2014–2018. JAMA 2019.

[3]. Rostron BL, Cheng YC, Gardner LD, et al. Prevalence and Reasons for Use of Flavored Cigars and ENDS among US Youth and Adults: Estimates from Wave 4 of the PATH Study, 2016–2017. American journal of health behavior 2020;44(1):76–81. [PubMed: 31783934]

[4]. Goldenson NI, Leventhal AM, Simpson KA, et al. A Review of the Use and Appeal of Flavored Electronic Cigarettes. Curr Addict Rep 2019;6(2):98–113. [PubMed: 31453046]

[5]. The Food and Drug Administration. FDA finalizes enforcement policy on unauthorized flavored cartridge-based e-cigarettes that appeal to children, including fruit and mint. Available at https://www.fda.gov/news-events/press-announcements/fda-finalizes-enforcement-policy-unauthorized-flavored-cartridge-based-e-cigarettes-appeal-children. 2020.

[6]. Ali FRM, Diaz MC, Vallone D, et al. E-cigarette Unit Sales, by Product and Flavor Type - United States, 2014–2020. MMWR Morb Mortal Wkly Rep 2020;69(37):1313–1318. [PubMed: 32941416]

[7]. Leventhal AM, Strong DR, Kirkpatrick MG, et al. Association of Electronic Cigarette Use With Initiation of Combustible Tobacco Product Smoking in Early Adolescence. JAMA 2015;314(7):700–707. [PubMed: 26284721]

[8]. Vogel EA, Cho J, McConnell RS, et al. Prevalence of Electronic Cigarette Dependence Among Youth and Its Association With Future Use. JAMA Netw Open 2020;3(2):e1921513. [PubMed: 32074292]

[9]. DiFranza JR, Savageau JA, Fletcher K, et al. Measuring the loss of autonomy over nicotine use in adolescents: the DANDY (Development and Assessment of Nicotine Dependence in Youths) study. Arch Pediatr Adolesc Med 2002;156(4):397–403. [PubMed: 11929376]

[10]. Goldenson NI, Leventhal AM, Stone MD, et al. Associations of Electronic Cigarette Nicotine Concentration With Subsequent Cigarette Smoking and Vaping Levels in Adolescents. JAMA pediatrics 2017;171(12):1192–1199. [PubMed: 29059261]

[11]. Rubin DB. Multiple imputation for nonresponse in surveys: John Wiley & Sons 2004.

[12]. Leventhal AM, Dai H. Prevalence of Flavored e-Cigarette Use Among Subpopulations of Adults in the United States. J Natl Cancer Inst 2020.

[13]. Krishnan-Sarin S, Green BG, Kong G, et al. Studying the interactive effects of menthol and nicotine among youth: An examination using e-cigarettes. Drug Alcohol Depend 2017;180:193–199. [PubMed: 28915478]

[14]. Leventhal A, Cho J, Barrington-Trimis J, et al. Sensory attributes of e-cigarette flavours and nicotine as mediators of interproduct differences in appeal among young adults. Tob Control 2020;29(6):679–686. [PubMed: 31852818]

[15]. Truth Initiative. E-cigarettes: Facts, stats and regulations, Available at https://truthinitiative.org/research-resources/emerging-tobacco-products/e-cigarettes-facts-stats-and-regulations. 2020.

[16]. The Food and Drug Administration. FDA Notifies Companies, Including Puff Bar, to Remove Flavored Disposable E-Cigarettes and Youth-Appealing E-Liquids from Market for Not Having Required Authorization. Issued on July 20, 2020. Available at https://www.fda.gov/news-events/press-announcements/fda-notifies-companies-including-puff-bar-remove-flavored-disposable-e-cigarettes-and-youth. 2020.

[17]. Jennifer Maloney. Puff Bar Defies FDA Crackdown on Fruity E-Cigarettesby Ditching the Tobacco. Wall Street Journal, March 2, 2021. Available at https://www.wsj.com/articles/puff-bar-defies-fda-crackdown-on-fruity-e-cigarettes-by-ditching-the-tobacco-11614681003.

What this paper adds –

- Previous research found that young adult e-cigarette users commonly use either fruit/sweet or menthol/mint flavors.
- “Ice” e-cigarette flavors - marketed as a combination of fruity/sweet and cooling flavors (e.g., “blueberry ice” or “melon ice”) - recently entered the U.S. market, but the prevalence and tobacco-related correlates of ice flavored e-cigarette use in young adults are unknown.
- This study provides the first evidence that young adult use of ice flavored e-cigarettes may be common and positively associated with combustible tobacco use, nicotine vaping frequency and dependence, and use of disposable e-cigarette devices.

Table.

Association of Ice-flavored e-Cigarette Use and with Tobacco Product Use Characteristics

Outcomes	No. (%) or Mean (SD)			Associations from regression models[a]			
				Ice vs. Menthol/Mint		Ice vs. Fruit/Sweet	
	Menthol/Mint[b] (n=60)	Fruit/Sweet[b] (n=116)	Ice[b] (n=168)	OR or b (95% CI)	P-Value	OR or b (95% CI)	P-Value
Categorical variables [c]							
Past 30-day combustible tobacco use (yes v. no)[d]	13 (21.7)	38 (32.8)	53 (31.5)	**2.7 (1.3,5.7)**	.01	1.2 (0.7,2.1)	.59
Device used most often							
Rechargeable/refillable tanks/pens or Othere[e]	15 (29.4)	60 (59.4)	45 (31.3)	Reference		Reference	
Juul or similar rechargeable with cartridges	12 (23.5)	6 (5.9)	5 (3.5)	**0.1 (0.03,0.45)**	.002	1.5 (0.4,5.6)	.57
Disposable without separate cartridges/pods	24 (47.1)	35 (34.7)	94 (65.3)	1.3 (0.6,2.8)	.54	**3.9 (2.1,7.4)**	<.001
Vaping dependence symptoms (yes v. no)[f]	40 (66.7)	49 (43.0)	112 (67.1)	1.0 (0.5,1.9)	.93	**2.6 (1.5,4.4)**	<.001
Past 6-month quit vaping attempt (yes v. no)[g]	23 (39.0)	43 (37.7)	85 (51.5)	1.7 (0.9,3.3)	.10	1.4 (0.8,2.4)	.19
Started vaping during vs. after high school[h]	40 (72.7)	71 (65.1)	122 (73.9)	1.1 (0.5,2.3)	.77	**1.9 (1.02,3.37)**	.04
Continuous variables (past 30 days) [i]							
No. days vaped[j]	12.2 (11.2)	12.1 (11.8)	17.0 (11.5)	**4.4 (1.0,7.7)**	.01	**3.6 (0.8,6.4)**	.01
No. vaping episodes/day[k]	9.0 (7.5)	7.6 (8.1)	10.8 (7.9)	1.5 (−0.8,3.8)	.19	**2.4 (0.5,4.3)**	.01
No. puffs/episode[l]	4.1 (5.2)	3.2 (4.1)	3.6 (3.4)	−0.4 (−1.6,0.8)	.49	0.3 (−0.7,1.3)	.55

Unless otherwise noted, n=344. Significant associations are depicted in bold. Abbreviations, OR: Odds Ratio, B: Unstandardized regression weight, CI: Confidence Interval

a: Multivariable model including e-cigarette flavor most often used variable and all covariates listed in Appendix Table 1 as simultaneous regressors.

b: The menthol/mint group collapsed “menthol”(n=23] or “mint”(n=37) responses; fruit/sweet (e.g., fruit, candy, dessert, buttery); and ice-fruit combinations (blueberry ice, melon 5ice, banana ice, ice pineapple).

c: No. (Column %) and ORs from logistic regression models shown.

d: Any use of cigarettes, big cigars, little cigars or cigarillos, or hookah water pipe, use ≥1 vs. 0 products.

e: “Mod or mech-mod rechargeable,” “Box mod,” “Other tank style device,” “Any other electronic nicotine device.” (available n=296).

f: Hooked on nicotine checklist for e-cigarettes 1 ≥ vs. 0 symptoms (n=341).

g: "During the past 6 months, have you stopped vaping for ≥1 day because you were trying to quit?" (n=338).

h: Vaping onset during vs. after high schools based on responses to ever e-cigarette use questions in survey waves administered when cohort was in high school (n=329).

i: Mean (SD) and bs from linear regression models shown.

j: Number of past 30-day vaping days. Responses ("0," "1–2" [recoded=1.5], "3–5" [recoded=4], "6–9" [recoded=7.5], "10–19" [recoded=14.5], "20–29" [recoded=24.5], or "30" [recoded=30] times. [range: 0–30]).

k: "In the past 30 days, on the days you vaped nicotine, how many times did you usually pick up your e-cigarette device to vape?" Responses ("0," "1," "2," "3–5" [recoded=4], "6–169" [recoded=7.5], "10–14" [recoded=12], "15–20" [recoded=17.5], or ">20" [recoded=20] times [range: 0–20]) (n=341).

l: "In the past 30 days, Each time you picked up your e-cigarette to vape, how many puffs did you usually take before putting it away?" ("0," "1," "2," "3–5" [recoded=4], "6–9" [recoded=7.5], "10–14" [recoded=12], "15–20" [recoded=17.5], or ">20" [recoded=20] times; range: 0–20) (n=343).