Published in final edited form as:

Tob Control. 2021 November ; 30(6): 638–643. doi:10.1136/tobaccocontrol-2020-055651.

Changes in knowledge, perceptions and use of JUUL among a cohort of young adults

Kimberly G Wagoner¹, Jessica L King², Cynthia K Suerken³, Beth A Reboussin³, Jennifer Cornacchione Ross¹, Erin L Sutfin¹

¹Department of Social Sciences and Health Policy, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA

²Department of Health and Kinesiology, University of Utah, Salt Lake City, Utah, USA

³Department of Biostatistics and Data Science, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA

Abstract

Objective—E-cigarettes have gained popularity, most recently with pod-style devices, such as JUUL. We examined changes in JUUL awareness, use, perceptions, nicotine content knowledge, number of days a pod lasts and exposure to JUUL retail advertising over a 6-month period in a cohort of young adults.

Methods—In spring and fall 2018, 1836 young adults completed online surveys on tobacco use, including JUUL perceptions and use behaviours. Demographics, tobacco use and JUUL advertising exposure in spring 2018 were examined as predictors of current JUUL use in fall 2018.

Results—Ever and current JUUL use doubled in 6 months (5.9% vs 12.7%, $p<0.001$; 1.6% vs 3.4%, $p<0.001$). The number of days a JUUL pod lasts significantly changed ($p=0.049$). Although there was an increase in those reporting JUUL has as much or more nicotine than a pack of cigarettes, 58% are ‘not sure’ of JUUL’s nicotine content. Exposure to JUUL’s advertising significantly increased (31.8% to 46.4%; $p<0.001$). In multivariable models, those perceiving JUUL as or more harmful than cigarettes, and former and never cigarette smokers had significantly lower odds of current JUUL use at 6 months compared with their respective counterparts ($p<0.0001$). Those reporting exposure to JUUL’s advertising had significantly increased odds of current JUUL use 6 months later ($p<0.03$).

Correspondence to Dr Kimberly G Wagoner, Social Sciences and Health Policy, Wake Forest School of Medicine, Winston-Salem, NC 27157, USA; kwagoner@wakehealth.edu.

Contributors KW and ELS designed the study. All authors contributed to the implementation of the study. BAR and CKS performed the statistical analyses. All authors contributed to writing and revising the manuscript.

Disclaimer The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study protocol was approved by the Wake Forest School of Medicine Institutional Review Board.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement There is currently no publicly available data for this study.

Twitter Jessica L King @jess4817

Conclusions—Findings demonstrate changes in knowledge of JUUL’s nicotine content, perceptions and use over a short period of time, suggesting frequent measurement is necessary. Additionally, efforts are needed to regulate retail advertising and ensure consumer education about product risks as they are associated with current use.

INTRODUCTION

E-cigarette use among young adults has increased in recent years. Data from the Monitoring the Future (MTF) study showed that prevalence of 30-day e-cigarette use among non-college young adults increased between 2017 and 2018, from 7.9% to 12.5%. Among college students, the 30-day prevalence more than doubled during the same timeframe from 6.1% to 15.5%, representing one of the greatest 1-year increases for any substance since MTF began.¹

Contributing to the increase is the latest generation of pod-style e-cigarettes that are discreetly designed. The most popular brand, JUUL, resembles a flash drive and fits in the palm of a hand.² JUUL’s single-use pods contain an e-liquid made of nicotine salts, benzoic acid, propylene glycol and glycerol, as well as other chemicals. The use of nicotine salts and benzoic acid lowers the pH of the liquid and allows nicotine to be delivered at high concentrations without harshness.³⁴ One JUUL pod can deliver as much nicotine as one pack of cigarettes, increasing users risk for nicotine addiction.²

JUUL became the most popular e-cigarette in the USA, claiming over 70% of market share.⁵ JUUL was heavily marketed to youth and young adults through social media platforms like Instagram and Twitter.⁶⁷ In 2017, JUUL’s marketing expanded to the retail environment,⁸⁹ the top source where youth and young adults report seeing e-cigarette advertising.¹⁰¹¹ After scrutiny from the US Food and Drug Administration (FDA), JUUL eliminated its social media presence and launched a new television campaign targeting adult smokers that included a \$10 million ad campaign to ‘Make the Switch’, from combustible cigarettes to JUUL.¹²

Recent studies have shown that young adults prefer pod-style devices, like JUUL, over non-pod devices due to aesthetics, functionality and social acceptability.¹³ Users report getting the same nicotine effect as combustible cigarettes and perceiving greater addiction to nicotine due to JUUL’s ease of use and being able to use it anywhere.¹⁴ In addition to product design features, young adults report using JUUL, because it is discreet and due to their curiosity.¹⁵¹⁶

Understanding why and how young adults use e-cigarettes, including JUUL, is important, as they are not without risk. Studies of other types of e-cigarettes show they emit lower levels of carcinogens compared with combustible cigarettes and can reduce the risk for tobacco-related disease.¹⁷¹⁸ However, e-cigarette use is associated with respiratory disease including chronic obstructive pulmonary disease, bronchitis, emphysema and asthma, as well as cardiovascular disease.^{19–23} Studies examining the specific harms related to JUUL are growing, with recent studies documenting its high nicotine concentration, cytotoxicity due to nicotine and flavour chemicals, and adverse effects on vascular endothelial function

in animal models.^{24–26} Additionally, studies have shown that a high proportion of JUUL users also report current cigarette smoking, indicating dual use and raising concerns of nicotine addiction.^{1527–30}

JUUL use is associated with younger age, white race, higher socioeconomic status, reduced risk perceptions, household use of e-cigarettes, high sensation seeking, and current combustible tobacco use.²⁸ A recent study examining a nationally representative cohort of individuals aged 15–34 years found that JUUL attracted new users, with ever and current use of JUUL more than doubling between 2018 and 2019, the same time period that JUUL dominated the e-cigarette market. Use was most popular with youth and young adults, especially 18–24 year olds. In addition, combustible tobacco use, lower harm perceptions, increased sensation seeking and peer's e-cigarette use were predictors of future JUUL use among e-cigarette naïve respondents.³¹

The goal of our study was to contribute to this growing literature using a cohort of young adults to assess changes in JUUL use over a shorter, 6-month period of time. We also explored changes in knowledge of JUUL's nicotine content, risk perceptions and exposure to JUUL advertising and examined associations with current JUUL use (ie, past 30 days).

METHODS

Sample

Data are from waves 11 (May/June 2018) and 12 (October/November 2018) of the Assessment of the post-College Experience (ACE) study. Questions specific to JUUL were added to these waves. The ACE cohort study began in fall 2010, when freshmen from nine public and two private colleges in North Carolina and Virginia were recruited to complete an online screener survey.³² Across the 11 colleges, 10,528 freshmen completed a screener survey to assess eligibility. Smokeless tobacco users, current cigarette smokers and males were oversampled; all other students were randomly sampled. We invited 4910 students to participate in the longitudinal study. In 2010, 3146 (64.2%) of those invited completed the baseline survey and joined the cohort (wave 1). Participants were then resurveyed biannually or annually between spring 2011 (wave 2) and fall 2018 (wave 12). For each survey wave, all participants were invited to complete the survey unless they had opted out of the study. Additional details on the methodology have been published previously.^{33–35}

Participants were contacted via email to complete the survey. The online survey took approximately 20 minutes to complete, and participants received a \$25 electronic gift card for completing spring 2018 (wave 11) and \$30 for fall 2018 (wave 12). A total of 1927 completed wave 11 and 1960 completed wave 12. There were 1836 participants that completed both waves 11 and 12 and are included in our analyses. Participants who completed both waves 11 and 12 were more likely to be female ($p<0.001$) and non-tobacco users ($p<0.001$) compared with the 1310 participants from the wave 1 cohort that did not complete both waves.

Measures

The same measures were used in both waves, except where indicated. Items were adapted from the Population Assessment of Tobacco and Health, the existing literature or developed by the authors.^{22836–39}

Awareness—To assess JUUL awareness, all participants read a description of JUUL, saw an image of JUUL and then were asked: ‘*before this survey, had you ever heard of JUUL e-cigarettes?*’ (yes/no).

JUUL use—We asked participants who reported awareness whether they ever tried JUUL, even one or two puffs. Those who had ever tried JUUL were considered ever users and were asked about frequency of use with the item: ‘*which of the following choices best describes your JUUL use?*’. Response options were ‘everyday’, ‘weekly’, ‘monthly’, ‘every couple of months’, ‘about once a year’ and ‘less than once a year’. Those who reported using JUUL everyday, weekly or monthly were considered current users. Those who reported using JUUL everyday, weekly, monthly or every couple of months were asked: ‘*about how many days does one pod last you?*’, with an open numerical response.

Knowledge of nicotine content—Among participants who reported awareness, we asked about their knowledge of JUUL nicotine levels using the item: ‘*about how much nicotine does one JUUL pod contain?*’, with response options ‘more nicotine than a pack of cigarettes’, ‘as much nicotine as a pack of cigarettes’ ‘less nicotine than a pack of cigarettes’, ‘no nicotine’ and ‘not sure’.

Reasons for use—We asked those who reported using JUUL every couple of months or more frequently to select the reasons they use JUUL from the following items³⁶⁴⁰: ‘my friends or family use it’, ‘it’s discreet’, ‘the pods are easy to use’, ‘it comes in flavors I like’, ‘it gives a strong throat hit’, ‘it doesn’t produce a lot of vapor’, ‘it gives a better buzz than alcohol’, ‘it gives a better buzz than marijuana’, ‘it may be better for my health than smoking cigarettes’, ‘to help me quit smoking or cut down on the number of cigarettes I smoke’ and ‘other’.

Exposure to JUUL advertising among retailers—To examine JUUL-specific advertising, we asked those who reported awareness, ‘*in the past 6 months, have you noticed JUUL advertisements or promotions on store windows or inside stores where JUUL is sold?*’, with response options ‘yes’, ‘no’ and ‘don’t know’.

Relative risk perception—We asked participants who reported awareness: ‘*Compared to cigarettes, JUUL is...*’, ‘much less harmful’, ‘a little less harmful’, ‘as harmful’ ‘a little more harmful’ or ‘much more harmful’. For analysis, responses were dichotomised into ‘much less/a little less harmful’ and ‘as/a little more/more harmful than cigarettes’.

Demographics—Sex (male/female) and race (white/non-white) were assessed during the screener survey. Age and income (<\$35 000/ \$35 000) were collected at each wave.

Cigarette smoking—Cigarette smoking was assessed at each wave. Those who reported smoking at least 100 cigarettes during their lifetime and cigarette use within the past 30 days were considered current smokers. Those who reported smoking at least 100 cigarettes during their lifetime but not in the past 30 days were considered former smokers. Those who reported never smoking or smoking less than 100 cigarettes during their lifetime were considered never smokers.

E-cigarette use—To assess e-cigarette use, we asked ‘*have you ever used an e-cigarette or other vaping device?*’. Response options were ‘yes, in the past week’, ‘yes, in the past 30 days, but more than a week ago’, ‘yes, in the past 6 months, but more than 30 days ago’, ‘yes, in the past year, but more than 6 months ago’, ‘yes, more than a year ago’ and ‘no, never’. Those who responded ‘yes, in the past week’ or ‘yes, in the past 30 days, but more than a week ago’ were considered current users. Those who reported use in the past 6 months, past year or more than a year ago were considered ever users. Those who responded no, never, were considered never users.

Other tobacco use—To assess use of other tobacco products (OTP), we separately asked for each tobacco product ‘*have you ever used a [cigar; cigarillo; smokeless tobacco product; waterpipe]?*’. Response options were ‘yes, in the past week’, ‘yes, in the past 30 days, but more than a week ago’, ‘yes, in the past 6 months, but more than 30 days ago’, ‘yes, in the past year, but more than 6 months ago’, ‘yes, more than a year ago’ and ‘no, never’. Those who responded ‘yes in the past week’ or ‘yes in the past 30 days, but more than a week ago’ were considered current users. Those who reported use in the past 6 months, past year or more than a year ago were considered ever users. Those who responded ‘no, never’ were considered never users.

Analysis

We calculated descriptive statistics for sample demographic characteristics and tobacco use including e-cigarette, combustible cigarette and OTP. All percentages, aside from demographic characteristics, were estimated using weights to account for oversampling of males and tobacco users. We examined longitudinal changes in outcomes from wave 11 to wave 12 using mixed-effects logistic regression models to account for repeated measures within an individual. A mixed-effects logistic model was used for binary outcomes and cumulative logit for ordered outcomes. To examine the influence of wave 11 predictors on wave 12 current JUUL use, we used multivariable logistic regression. Wave 11 predictors included sex, race, income, combustible cigarette smoking, OTP use, risk perceptions and exposure to JUUL retail advertising. Wave 11 e-cigarette and JUUL use were highly collinear with wave 12 JUUL use and were, therefore, not included in the model. Associations between wave 11 and wave 12 JUUL and e-cigarette use were examined separately. All models were fit using Proc Glimmix in SAS V.9.4 and accounted for sampling weights.

RESULTS

A total of 1836 participants completed both surveys and were included in the analyses. Participants were 52.4% female, 84.6% white and 65.0% had an income of \$35 000 (measured at wave 12). The mean age was 26.2 years (SD=0.5). Approximately 4.7% were current cigarette smokers, 8.0% former smokers and 87.3% were never cigarette smokers. Current e-cigarette use was reported by 11.6% and 29.7% reported ever e-cigarette use. Eight percent reported current OTP use and 59.0% reported ever use (table 1).

Awareness

Awareness of JUUL significantly increased from 34.8% (spring 2018) to 65.2% (fall 2018) ($p<0.001$) (table 2).

JUUL use

Among the sample, ever use of JUUL more than doubled from 5.9% (spring 2018) to 12.7% (fall 2018) ($p<0.001$). Current use of JUUL also significantly increased from 1.6% to 3.4% ($p<0.001$) (table 2). Most current JUUL users also identified as current e-cigarette users (98.3%, spring 2018 and 94.4%, fall 2018). Across the two waves among ever users, frequency of use did not significantly change, with most participants reporting episodic or experimental use (ie, every couple of months or longer). We found significant changes in how long one JUUL pod lasts users. Among those who reported use at least every couple of months, we found an increase in the prevalence of a pod lasting a day or less (12.9% to 21.6%); a decrease in the prevalence of one pod lasting a week or less (from 59.8% to 42.0%); and an increase in the prevalence of a pod lasting more than a week (ie, 8 or more days) (27.4% to 36.4%) ($p=0.049$).

Reasons for use

Reasons for use did not change between waves. Among those who reported use every couple of months or more, the most common responses included, '*it's discreet*' (53.0%, spring 2018; 53.4%, fall 2018), '*friends or family use it*' (45.1%; 52.1%), '*pods are easy to use*' (44.9%; 44.8%) and '*it comes in flavors I like*' (34.9%; 37.8%). Approximately one-third of participants indicated using JUUL because '*it may be better for my health than smoking cigarettes*' (36.8%; 35.7%), and about one-quarter endorsed '*using JUUL to help quit smoking or cut down on the number of cigarettes smoked*' (25.6%; 22.4%).

Knowledge of nicotine content

Among those who were aware of JUUL, knowledge of the nicotine content of one JUUL pod significantly changed between waves ($p=0.02$) (table 2). Lack of knowledge was the most endorsed response at both waves, despite a decrease from 66.3% to 58.1% between waves. At wave 12, the prevalence of respondents indicating JUUL contained as much nicotine as a pack of cigarettes increased compared with wave 11 (18.2% vs 21.5%). We found similar results for '*more nicotine than a pack of cigarettes*' (10.4% vs 14.2%).

Exposure to JUUL retail advertising

Among those aware of JUUL, we found a statistically significant increase in the prevalence of exposure to JUUL advertising in the retail environment from spring 2018 to fall 2018. Exposure increased from 31.8% to 46.4% ($p<0.001$) (table 2).

Relative risk perceptions

There was no significant difference of the relative risk perception of JUUL compared with cigarettes among those aware of JUUL. At each wave, approximately half of participants (51.1% and 52.7%) reported JUUL is as or more harmful than cigarettes (table 2).

Predictors of JUUL use

We assessed the influence of wave 11 predictors of current JUUL use at wave 12 including sex (female vs male), race (non-white vs white), income ($\geq \$35\,000$ vs $<\$35\,000$), cigarette smoking (current, former and never), OTP use (current, ever and never), relative risk perception (JUUL as or more harmful than cigarettes vs less harmful than cigarettes) and JUUL retail advertising exposure (yes vs no) (table 3). Those who perceived JUUL to be as or more harmful than cigarettes at wave 11 had lower odds of current JUUL use at wave 12 (Adjusted odds ratio (AOR): 0.43, 95% CI 0.19–0.94, $p=0.03$). Former and never cigarette smokers compared with current smokers at wave 11 had lower odds of current JUUL use at wave 12 (AOR: 0.20, 95% CI 0.08–0.48 and AOR: 0.05, 95% CI 0.02–0.11, $p<0.0001$, respectively). Participants reporting exposure to JUUL advertising at wave 11 had higher odds of current JUUL use at wave 12 (AOR: 2.23, 95% CI 1.10–4.53, $p=0.03$). No other significant predictors were found.

DISCUSSION

Our study is among the first to longitudinally assess changes in young adults' knowledge, risk perceptions and use of JUUL over time. In a 6-month timeframe, awareness increased, and ever and current use of JUUL doubled. These findings mirror trends of adolescent e-cigarette use⁴¹ and are consistent with a recent longitudinal study that found similar increases in ever and current use among young adults over a 1-year timeframe.³¹ However, our study highlights that increase in use was rapid, occurring in just 6 months. We also found slightly higher prevalences of ever and current use, likely due to the younger age of our sample (26.2 years compared with 25–34 years). Our study further explored use by examining how long one pod lasts a user and found that JUUL pods are being consumed more quickly over time for some users. We also found an increase in a pod lasting eight or more days, which could be due to several reasons including more experimentation, switching pods to try different flavours or less frequent use. These findings demonstrate how much JUUL use changed over a short period of time, supporting findings that JUUL was a popular e-cigarette brand and that awareness and use increased rapidly. It also underscores the need for more frequent measurement, especially during this time of new tobacco product innovation.

Consistent with other studies, the majority of participants indicated they did not know the amount of nicotine in one JUUL pod.¹⁶²⁹ Our measure assessed participants' knowledge

of the nicotine content compared with a pack of combustible cigarettes, which may be a challenging comparison for participants, especially those who do not smoke cigarettes. The lack of knowledge could also be due to labelling practices, which are currently unregulated, that report nicotine content as a percentage of volume. More research is needed to understand how consumers interpret the current nicotine content labelling on JUUL to determine the best way to communicate this information.

Also in line with previous research, the most common reason reported for use was JUUL's discreetness.¹⁶ While being able to hide use has been reported as a main reason for use among youth, primarily to conceal it from parents and teachers,⁷⁴² hiding use for young adults may be related to using JUUL in places where use is prohibited, such as the workplace, restaurants and movies.¹³⁴³ It could also be attributed to social norms, with users wanting to conceal their use from others who they think may disapprove. It is worth noting that about half of users in our sample reported using JUUL because friends or family use it, indicating that for some young adult users social influences may play an important role.³⁰⁴⁴ Finally, about a quarter (22%) of the sample reported using JUUL to help them quit cigarette smoking or cut back on the number of cigarettes smoked, although the products are not approved as cessation aids by the FDA. Randomised clinical trials are needed to determine the role that these high nicotine delivery, pod-based e-cigarettes play in cigarette consumption, quit attempts and cessation, as none have been published to date. While JUUL's high nicotine delivery may satisfy cigarette smokers' cravings and potentially help them completely switch to e-cigarettes, studies have shown that a high proportion of JUUL users also report current cigarette smoking indicating possible dual use.¹⁵²⁷⁻³¹ We found former and never smokers had lower odds of current JUUL use compared with current cigarette smokers, suggesting potential dual use of JUUL and cigarette smoking in our study as well. Thus, more research is needed to determine how cigarette smokers are using JUUL and other pod-based systems.

Our finding that exposure to JUUL advertising in the retail setting is a significant predictor of current use has implications for advertising regulations. In 2018, when this study was conducted, JUUL Labs had the highest single-year e-cigarette advertising expenditures in the USA among all e-cigarette manufacturers, totalling \$73 million.⁸ JUUL's marketing included full-page newspaper advertisements,⁴⁵ increased point-of-sale advertising,⁹ as well as television and radio commercials.⁸⁴⁶ Although e-cigarettes are regulated by the FDA, states and local communities are not pre-empted from implementing restrictions on advertising. Our findings highlight the need to implement comprehensive approaches to address tobacco marketing such as regulating advertising and product placement within the retailer, requiring health warnings at the point-of-sale, restricting storefront advertising and retailer incentive programmes.¹⁰⁴⁷⁻⁴⁹

Finally, the FDA's recent policy to prioritise enforcement against unauthorised flavoured cartridge-based e-cigarettes, except tobacco and menthol,⁵⁰ will certainly have implications on JUUL use. While it is likely to discourage some from initiating use with JUUL or other pod-based e-cigarettes, it is unknown if users will switch to allowed flavours,⁵⁵ discontinue use or switch to another cigarette style, such as tank-based systems where flavours are

currently still allowed. Thus, further research is warranted to determine the long-term effects of this product-specific policy enforcement strategy.

Public health efforts should continue to monitor awareness, risk perceptions and use of JUUL, as well as other novel nicotine products that are introduced to the market, as our study demonstrated that awareness and use can change rapidly. More frequent surveillance is warranted, as the e-cigarette category is volatile, with increased scrutiny from the FDA, regular media attention and lawsuits quickly changing the product landscape. Young adults are an important population to consider since they are attracted to these novel devices and are often among early adopters. Public health campaigns that target this population are needed.

Study limitations include a predominantly regionally based cohort of college-educated young adults that were predominantly white, female and non-cigarette smokers. This cohort has completed approximately 12 tobacco-related surveys over the past 9 years, and therefore, may be more aware of tobacco-related advertising. Our measurement of relative risk perception compared harmfulness of JUUL and cigarettes in the same item instead of asking about product perceptions separately, which may have introduced bias.

Acknowledgments

Funding Research reported in this publication was supported by the National Cancer Institute of the National Institutes of Health under Award Number R01CA141643.

REFERENCES

- Schulenberg JE, Johnston LD, O'Malley PM, et al. Monitoring the future national survey results on drug use, 1975–2018: volume II, college students and adults ages 19–60. Ann Arbor: Institute for Social Research, The University of Michigan, 2019.
- Willett JG, Bennett M, Hair EC, et al. Recognition, use and perceptions of JUUL among youth and young adults. *Tob Control* 2019;28:tobaccocontrol-2018-054273–116.
- Duell AK, Pankow JF, Peyton DH. Free-Base Nicotine Determination in Electronic Cigarette Liquids by ¹H NMR Spectroscopy. *Chem Res Toxicol* 2018;31:431–4. [PubMed: 29775302]
- Krishnan-Sarin S, Jackson A, Morean M, et al. E-Cigarette devices used by high-school youth. *Drug Alcohol Depend* 2019;194:395–400. [PubMed: 30497057]
- aKP HB. Cig vol declines moderate. Nielsen: tobacco all channel data through 7/13. San Francisco, CA, 2019.
- Jackler RK, Ramamurthi D. Nicotine arms race: JUUL and the high-nicotine product market. *Tob Control* 2019;28:623–8. [PubMed: 30733312]
- Ramamurthi D, Chau C, Jackler RK. JUUL and other stealth vaporisers: hiding the habit from parents and teachers. *Tob Control* 2018. doi:10.1136/tobaccocontrol-2018-054455. [Epub ahead of print: 15 Sep 2018]. *Tob Control*.
- Ali FRM, Marynak KL, Kim Y, et al. E-Cigarette advertising expenditures in the United States, 2014–2018. *Tob Control* 2020. doi:10.1136/tobaccocontrol-2019-055424. [Epub ahead of print: 27 Feb 2020].
- Huang J, Duan Z, Kwok J, et al. Vaping versus JUULing: how the extraordinary growth and marketing of JUUL transformed the US retail e-cigarette market. *Tob Control* 2019;28:146–51. [PubMed: 29853561]
- US Department of Health and Human Services. E-Cigarette use among youth and young adults: a report of the surgeon General. Atlanta, GA, 2016.
- Initiative T Vaporized: youth and young adult exposure to e-cigarette marketing, 2015.

12. LaVito A JUUL combats criticism with new TV AD campaign featuring adult smokers who quit after switching to e-cigarettes, 2019. <https://www.cnbc.com/2019/01/07/juul-highlights-smokers-switching-to-e-cigarettes-in-ad-campaign.html>
13. Keamy-Minor E, McQuoid J, Ling PM. Young adult perceptions of JUUL and other pod electronic cigarette devices in California: a qualitative study. *BMJ Open* 2019;9:e026306.
14. Nardone N, Helen GS, Addo N, et al. JUUL electronic cigarettes: nicotine exposure and the user experience. *Drug Alcohol Depend* 2019;203:83–7. [PubMed: 31408770]
15. Ickes M, Hester JW, Wiggins AT, et al. Prevalence and reasons for Juul use among college students. *J Am Coll Health* 2020;68:1–5. [PubMed: 30365914]
16. McKelvey K, Halpern-Felsher B. How and why California young adults are using different brands of Pod-Type electronic cigarettes in 2019: implications for researchers and regulators. *J Adolesc Health* 2020;67:46–52. [PubMed: 32192827]
17. National Academies of Sciences E, and Medicine. Public health consequences of e-cigarettes. Washington, DC: The National Academies Press, 2018.
18. Goniewicz ML, Knysak J, Gawron M, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control* 2014;23:133–9. [PubMed: 23467656]
19. Carnevale R, Sciarretta S, Violi F, et al. Acute impact of tobacco vs electronic cigarette smoking on oxidative stress and vascular function. *Chest* 2016;150:606–12. [PubMed: 27108682]
20. Vlachopoulos C, Ioakeimidis N, Abdelrasoul M, et al. Electronic cigarette smoking increases aortic stiffness and blood pressure in young smokers. *J Am Coll Cardiol* 2016;67:2802–3. [PubMed: 27282901]
21. Bhatta DN, Glantz SA. Association of e-cigarette use with respiratory disease among adults: a longitudinal analysis. *Am J Prev Med* 2020;58:182–90. [PubMed: 31859175]
22. Alzahrani T, Pena I, Temesgen N, et al. Association between electronic cigarette use and myocardial infarction. *Am J Prev Med* 2018;55:455–61. [PubMed: 30166079]
23. Glantz SA, Bareham DW, Use E-Cigarettes: E-Cigarettes: use, effects on smoking, risks, and policy implications. *Annu Rev Public Health* 2018;39:215–35. [PubMed: 29323609]
24. Rao P, Liu J, Springer ML. JUUL and combusted cigarettes comparably impair endothelial function. *Tob Regul Sci* 2020;6:30–7. [PubMed: 31930162]
25. Omaiye EE, McWhirter KJ, Luo W, et al. High-Nicotine electronic cigarette products: toxicity of JUUL fluids and aerosols correlates strongly with nicotine and some flavor chemical concentrations. *Chem Res Toxicol* 2019;32:1058–69. [PubMed: 30896936]
26. Talih S, Salman R, El-Hage R, et al. Characteristics and toxicant emissions of JUUL electronic cigarettes. *Tob Control* 2019;28:678–80. [PubMed: 30745326]
27. Case KR, Hinds JT, Creamer MR, et al. Who is JUULing and why? an examination of young adult electronic nicotine delivery systems users. *J Adolesc Health* 2020;66:48–55. [PubMed: 31481286]
28. Vallone DM, Bennett M, Xiao H, et al. Prevalence and correlates of JUUL use among a national sample of youth and young adults. *Tob Control* 2019;28:603–9. [PubMed: 30377241]
29. McKelvey K, Baiocchi M, Halpern-Felsher B. Adolescents' and young adults' use and perceptions of Pod-Based electronic cigarettes. *JAMA Netw Open* 2018;1:e183535. [PubMed: 30646249]
30. Leavens ELS, Stevens EM, Brett EI, et al. JUUL electronic cigarette use patterns, other tobacco product use, and reasons for use among ever users: results from a convenience sample. *Addict Behav* 2019;95:178–83. [PubMed: 30933713]
31. Vallone DM, Cuccia AF, Briggs J, et al. Electronic cigarette and JUUL use among adolescents and young adults. *JAMA Pediatr* 2020. doi:10.1001/jamapediatrics.2019.5436. [Epub ahead of print: 21 Jan 2020].
32. Spangler J, Song E, Pockey J, et al. Correlates of smokeless tobacco use among first year college students. *Health Educ J* 2014;73:693–701. [PubMed: 25484378]
33. Suerken CK, Reboussin BA, Sutfin EL, et al. Prevalence of marijuana use at College entry and risk factors for initiation during freshman year. *Addict Behav* 2014;39:302–7. [PubMed: 24455784]
34. Wolfson M, Pockey JR, Reboussin BA, et al. First-Year college students' interest in trying dissolvable tobacco products. *Drug Alcohol Depend* 2014;134:309–13. [PubMed: 24309296]

35. Sutfin EL, Reboussin BA, Debinski B, et al. The impact of trying electronic cigarettes on cigarette smoking by college students: a prospective analysis. *Am J Public Health* 2015;105:e83–9.
36. ed. United States Department of Health and Human Services, National Institutes of Health, National Institute on Drug Abuse, United States Department of Health and Human Services, Food and Drug Administration, Center for Tobacco Products. Population Assessment of Tobacco and Health (PATH) Study [United States] Wave 2: Adult Questionnaire In: Inter-university Consortium for Political and Social Research, 2018.
37. Wackowski OA, Delnevo CD. Young adults' risk perceptions of various tobacco products relative to cigarettes: results from the National young adult health survey. *Health Educ Behav* 2016;43:328–36. [PubMed: 26304709]
38. Wackowski OA, Delnevo CD, Lewis MJ. Risk perceptions of menthol cigarettes compared with nonmenthol cigarettes among new Jersey adults. *Nicotine Tob Res* 2010;12:786–90. [PubMed: 20522521]
39. Czoli CD, Fong GT, Mays D, et al. How do consumers perceive differences in risk across nicotine products? A review of relative risk perceptions across smokeless tobacco, e-cigarettes, nicotine replacement therapy and combustible cigarettes. *Tob Control* 2017;26:e49–58. [PubMed: 27625408]
40. Saddleson ML, Kozlowski LT, Giovino GA, et al. Enjoyment and other reasons for electronic cigarette use: results from college students in New York. *Addict Behav* 2016;54:33–9. [PubMed: 26704429]
41. Wang TW, Asman K, Gentzke AS, et al. Tobacco Product Use Among Adults - United States, 2017. *MMWR Morb Mortal Wkly Rep* 2018;67:1225–32. [PubMed: 30408019]
42. Hammond D, Wackowski OA, Reid JL, et al. Use of JUUL e-cigarettes among youth in the United States. *Nicotine Tob Res* 2020;22:827–32. [PubMed: 30371838]
43. Yingst JM, Lester C, Veldheer S, et al. E-Cigarette users commonly stealth vape in places where e-cigarette use is prohibited. *Tob Control* 2019;28:493–7. [PubMed: 30097510]
44. Kavuluru R, Han S, Hahn EJ. On the popularity of the USB flash drive-shaped electronic cigarette Juul. *Tob Control* 2019;28:3.
45. Jackler RK, Chau C, Getachew BD. JUUL advertising over its first three years on the market. Stanford Research into the Impact of Tobacco Advertising, 2019.
46. Gebel M JUUL is spending \$10 million on a TV ad campaign aimed at adults, amid criticism that its e-cigarettes get teens hooked, 2019. <https://www.businessinsider.com/juuls-10-million-tv-ad-campaign-is-aimed-at-adults-who-want-to-quit-cigarettes-2019-1>
47. ChangeLab Solutions. Point of sale Playbook: policy options to regulate the sale and marketing of tobacco products, 2016. Available: <https://www.changelabsolutions.org/product/point-sale-playbook> [Accessed 15 Apr 2020].
48. Tobacco Counter. Options for point of sale activities in states and localities that are Preempted, 2020. Available: <https://countertobacco.org/preemption/>
49. Rogers T, Feighery EC, Tencati EM, et al. Community mobilization to reduce point-of-purchase advertising of tobacco products. *Health Educ Q* 1995;22:427–42. [PubMed: 8550368]
50. U.S. Department of Health and Human Services. Enforcement priorities for electronic nicotine delivery systems (ends) and other deemed products on the market without Premarket authorization: guidance for industry. Silver Spring, MD: U.S. Food and Drug Administration, 2020.

What this paper adds**What is already known on this subject**

- JUUL has been heavily marketed to youth and young adults, helping it to dominate the e-cigarette market.
- Much attention has focused on the prevalence of JUUL use among youth.

What important gaps in knowledge exist on this topic

- Although the literature focused on JUUL is growing, most studies have been cross-sectional and focused on youth prevalence, leaving the young adult population understudied.

What this paper adds

- In this cohort study of 1836 participants, we found significant changes in a short, 6-month timeframe in ever and current use of JUUL, JUUL pod duration, knowledge of nicotine content and exposure to JUUL advertising in the retail setting. Exposure to advertising was associated with higher odds of current use 6 months later, while perceptions that JUUL is as or more harmful than cigarettes was associated with lower odds of use 6 months later. Former and never smokers, compared with current smokers, also had lower odds of current use 6 months later.

Table 1

Sample demographics (n=1836)

	Wave 11 Spring 2018	Wave 12 Fall 2018
Age	25.8 (0.6)	26.2 (0.5)
Sex (%)		
Male	47.5	47.6
Female	52.5	52.4
Race (%)		
White	84.6	84.6
Non-white	15.4	15.4
Income (%)		
<\$35 000	37.2	35.0
\$35 000	62.8	65.0
E-cigarette use (%)		
Current	10.4	11.6
Ever	29.2	29.7
Never	60.8	58.7
Cigarette smoking (%)		
Current	5.1	4.7
Former	7.4	8.0
Never	87.5	87.3
OTP use(%)		
Current	8.5	8.0
Ever	58.0	59.0
Never	33.5	33.1

Table 2

JUUL awareness, use behaviours, knowledge, perceptions and exposure to advertising

	Wave 11 Spring 2018 (%)	Wave 12 Fall 2018 (%)	P value
Awareness of JUUL *	34.8	65.2	<0.001
Ever use *	5.9	12.7	<0.001
Current JUUL use *	1.6	3.4	<0.001
JUUL use frequency †			0.31 (at least monthly vs >monthly)
Everyday	12.3	12.7	
Weekly	7.5	7.1	
Monthly	6.7	7.1	
Every couple months or more	11.9	18.2	
Once a year	15.1	13.9	
Less than one time per year	46.4	41.1	
One pod lasts me ‡			0.049
1 day or less	12.9	21.6	
2–7 days	59.8	42.0	
8 or more days	27.4	36.4	
Reasons for use ‡			
Friends/family use	45.1	52.1	0.84
Discreet	53.0	53.4	0.88
Pods easy to use	44.9	44.8	0.76
It comes in flavours I like	34.9	37.8	0.87
Better for my health than cigarettes	36.8	35.7	0.86
Quit smoking or cut down on number of cigarettes smoked	25.6	22.4	0.99
Does not produce a lot of vapour	12.3	14.9	0.69
Strong throat hit	15.2	17.2	0.77
Better buzz than alcohol	12.3	5.8	0.46
Knowledge of nicotine content in one JUUL pod §			0.02
More nicotine than a pack of cigarettes	10.4	14.2	
As much nicotine as a pack of cigarettes	18.2	21.5	
Less nicotine than a pack of cigarettes	5.1	5.9	
No nicotine	0.1	0.2	
Not sure	66.3	58.1	
Exposure to JUUL retail advertising §	31.8	46.4	<0.001
Relative risk perception compared with cigarettes § (% endorsed: JUUL is as or more harmful than cigarettes)	51.1	52.7	0.35

* Among full sample (n=1836).

† Among ever users (wave 11: n=152; wave 12: n=296).

[‡] Among those reporting use everyday, weekly, monthly or every couple of months (wave 11: n=70; wave 12: n=155).

[§] Among those aware (wave 11: n=703; wave 12: n=1235).

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3Predictors of current JUUL use at wave 12, n=680^{*}

Female	0.47	0.22	1.01	0.054
Non-white	0.45	0.11	1.91	0.28
\$35 000 or more	2.24	0.97	5.15	0.059
Cigarette use (former vs current)	0.20	0.08	0.48	<0.0001
Cigarette use (never vs current)	0.05	0.02	0.11	
Other tobacco use (ever vs current)	0.66	0.29	1.54	0.20
Other tobacco use (never vs current)	0.05	0.001	1.70	
JUUL as harmful or more harmful than cigarettes	0.43	0.19	0.94	0.03
Exposure to JUUL retail advertising	2.23	1.10	4.53	0.03

^{*} Sample restricted to those who reported being aware of JUUL.