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JUUL RELEASES MORE NICOTINE IN THE FIRST PUFFS

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Analytical studies that estimate nicotine and other toxicant emissions from electronic cigarettes (e-cigarettes) typically employ a puffing machine to generate 10 or 15 puffs in rapid succession (e.g., 30s between puffs) for subsequent assays.[1, 2] Such puffing patterns model combustible cigarette use in which every hour or so a smoker takes a 5-minute break to consume a cigarette, a use duration intrinsic to the burning rate and length of the cigarette rod. A single cigarette is the default "serving size" to which the consumer commits once the cigarette has been lit. On the other hand, e-cigarettes such as JUUL have no intrinsic serving size; the design is agnostic to a user drawing a single puff or tens of puffs in a use bout. Indeed, emerging evidence suggests that JUUL use patterns are characterized by sporadic puffing throughout the day, e.g., at the work desk, during exercise, and during class.[3, 4] A recent study found that nearly half of exclusive JUUL users report typically drawing four or fewer puffs from their device during a use bout [5]. We examined whether using JUUL in such a manner might result in different nicotine emissions per puff than predicted by a standardized 10-puff regimen.

We measured puff-by-puff liquid consumption for two JUUL products obtained in the UK in 2019: Golden Tobacco (20mg/ml label) and "New Technology" Golden Tobacco (18mg/mL label) JUUL pods. Three brand-new pods of each product were used to each generate three puffing bouts consisting of ten 4-sec puffs with a 1L/min flow rate and 30s inter-puff interval, within the range of recently reported JUUL topography parameters.[6] Each bout was separated by 30 minutes. We fully recharged the same battery prior to every

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AUTHOR CONTRIBUTIONS

RS, ST, EK, NK, and AS designed the experiments. RS, EK, and NK performed the measurements. RS, ST, EK and AS analyzed the data. AS, ST, RS, EK, NK and DA wrote the original draft.

DECLARATION OF INTERESTS

The authors declare the following competing financial interest: Dr. Shihadeh is named on a patent application for a device that measures the puffing behavior of electronic cigarette users and is a paid consultant in litigation against the tobacco industry.

DISCLAIMER

The content is solely the responsibility of the authors and does not necessarily represent the views of the NIH or the FDA.

session to power each JUUL pod. The amount of aerosol emitted per puff was determined gravimetrically by weighing the JUUL device after each puff, during the inter-puff interval. Nicotine yield per puff was estimated as the product of the liquid consumed per puff and the previously measured liquid nicotine concentration of 19mg/mL for both products.[7] Puff-by-puff computed nicotine emissions are presented in Figure 1.

We found that for both product types, the computed nicotine yield was greatest during the first puffs, and systematically decreased until steadying at the fifth puff. The same trend was observed in every test session, including repeats with the same pods (i.e., after the 30min rest period). These results suggest that previous reports of JUUL nicotine yields that are based on the emissions collected from a succession of 10–15 puffs [8–10] underestimate the true per-puff nicotine intake of a JUUL user because they average the emissions from all 15 puffs. One limitation is that we only tested one topography regimen, others may yield different result but are unlikely to affect the general conclusion of this study that the first JUUL puffs result in higher emissions, as routinely reported in online user forums. The tobacco industry has long recognized the importance to dependence formation of the first puffs of a cigarette “which are more likely to be noticed and assessed by a smoker” and has manipulated cigarette chemistry accordingly.[11] It is not clear whether JUUL’s higher emissions in the first few puffs are intentional design features, or how this may affect its abuse liability profile. These questions are worth investigating.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

[1]. El-Hellani A, Salman R, El-Hage R, et al. Nicotine and Carbonyl Emissions From Popular Electronic Cigarette Products: Correlation to Liquid Composition and Design Characteristics. Nicotine Tob Res 2016;20(2):215–223.

[2]. Goniewicz ML, Hajek P, McRobbie H. Nicotine content of electronic cigarettes, its release in vapour and its consistency across batches: regulatory implications. Addiction 2014;109(3):500–507. [PubMed: 24345184]

[3]. Paul K. Breaking up with my Juul: why quitting vaping is harder than quitting cigarettes. https://www.theguardian.com/society/2019/oct/10/breaking-up-with-my-juul-why-quitting-vaping-is-harder-than-quitting-cigarettes (Published 2019).(Accessed 3/16/2021).

[4]. Ibarra A B Vapers seek relief from nicotine addiction in — wait for it — cigarettes. https://www.nbcnews.com/health/vaping/vapers-seek-relief-nicotine-addiction-wait-it-cigarettes-n1054131 (Published 2019).(Accessed 3/16/2021).

[5]. 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;95:178–183. [PubMed: 30933713]

[6]. Vargas-Rivera M, Ebrahimi Kalan M, Ward-Peterson M, et al. Effect of flavour manipulation on ENDS (JUUL) users’ experiences, puffing behaviour and nicotine exposure among US college students. Tob Control 2020:tobaccocontrol.

[7]. Karam E, Talih S, Salman R, et al. Juul 'new technology' pods exhibit greater electrical power and nicotine output than previous devices (in review). Tob Control 2021.

[8]. Talih S, Salman R, El-Hage R, et al. Characteristics and toxicant emissions of JUUL electronic cigarettes. Tob Control 2019;28(6):678–680. [PubMed: 30745326]

[9]. Reilly SM, Bitzer ZT, Goel R, et al. Free Radical, Carbonyl, and Nicotine Levels Produced by Juul Electronic Cigarettes. Nicotine & Tobacco Research 2018:nty221–nty221.

[10]. Goniewicz ML, Boykan R, Messina CR, et al. High exposure to nicotine among adolescents who use Juul and other vape pod systems ('pods'). Tob Control 2018.

[11]. Creighton DE. Structured creativity group presentation project proposals: 1. Front end lift 2. Compensatable filters. https://www.industrydocuments.ucsf.edu/docs/jfdb0223 (Published 1984).

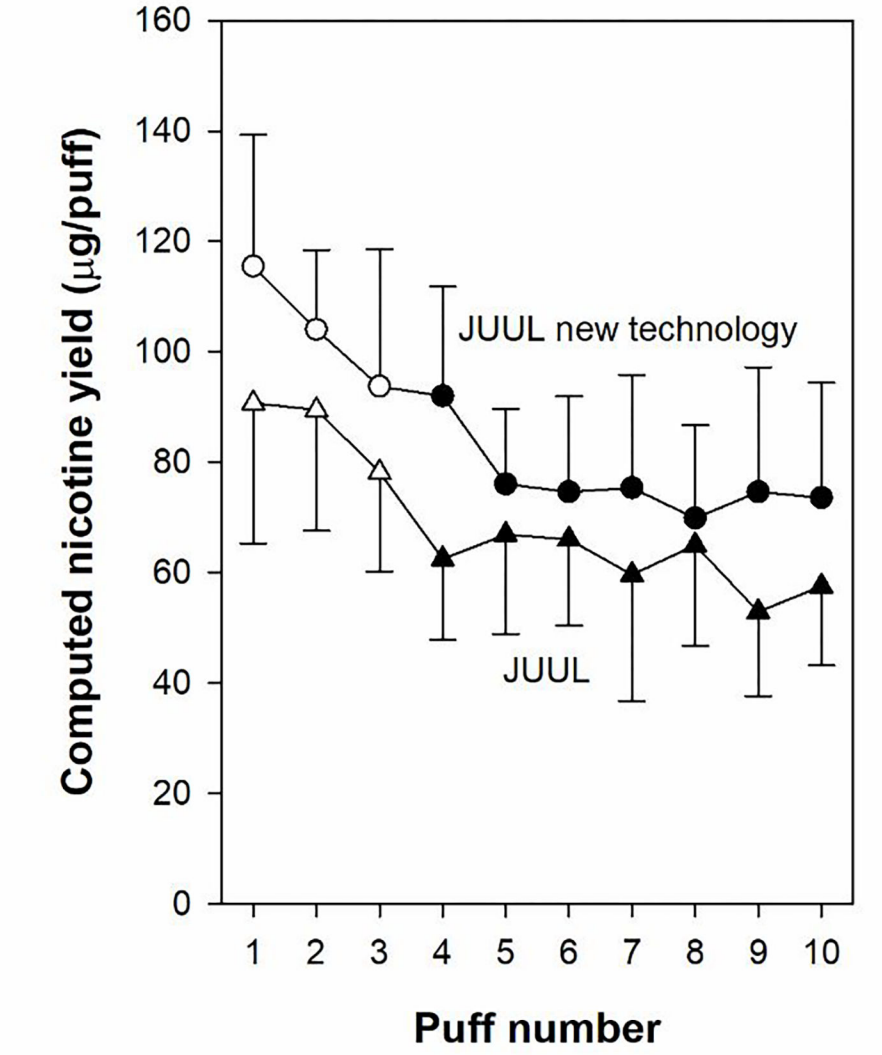

Figure 1.

Computed nicotine yield by puff from JUUL and JUUL new technology pods. Each data point represents the average (standard deviation) obtained from three JUUL pods used during three different bouts (N=9 for each data point). Filled symbols indicate a significant difference from the first puff. Additionally, a general linear model analysis showed that puff number is significantly associated with the computed nicotine yield per puff.