

Table 1. Descriptive Characteristics of the Sample, Overall and by Current E-Cig Device Type

Characteristic	Overall (<i>n</i> = 4421)	Current first generation e-cig device user (<i>n</i> = 1048)	Current advanced generation e-cig device user (<i>n</i> = 3373)	<i>P</i>
Mean age (in years) (<i>SD</i>)	40.1 (12.7)	43.9 (13.6)	39.0 (12.2)	<.0001
Male, % (<i>n</i>)	71.2 (3148)	55.1 (577)	76.2 (2571)	<.0001
White, % (<i>n</i>)	91.8 (4057)	91.2 (956)	91.9 (3101)	.4623
>High school diploma, % (<i>n</i>)	83.8 (3704)	81.7 (856)	84.4 (2848)	.0345
Current smoker, % (<i>n</i>)	17.9 (764)	39.0 (409)	10.5 (355)	<.0001
Mean Penn State Electronic Cigarette Dependence Index (<i>SD</i>)	8.0 (3.5)	7.1 (4.0)	8.3 (3.3)	<.0001
Mean use time (months) (<i>SD</i>)	11.8 (12.4)	8.3 (10.1)	12.9 (12.8)	<.0001
Mean use times per day (<i>SD</i>)	21.7 (24.5)	11.7 (16.8)	24.8 (25.7)	<.0001
Mean time to first use after waking (in minutes) (<i>SD</i>)	45.5 (78.0)	67.3 (116.1)	38.7 (60.0)	<.0001
Mean number of devices purchased prior to current device (<i>SD</i>)	3.5 (2.7)	2.3 (2.0)	3.9 (2.8)	<.0001
First device purchased was a first generation, % (<i>n</i>)	58.9 (2603)	90.2 (945)	49.2 (1658)	<.0001
Mean nicotine concentration of liquid (in mg/ml) (<i>SD</i>)	16.0 (8.6)	19.1 (12.7)	15.1 (6.6)	<.0001
Intended to quit smoking when starting e-cig use, % (<i>n</i>)	74.7 (3301)	70.9 (743)	75.8 (2558)	.0013
Stated they felt e-cig helped them to quit smoking, % (<i>n</i>)	92.4 (4085)	76.5 (802)	97.3 (3283)	<.0001
Using flavored liquid, % (<i>n</i>) (<i>n</i> = 3080)	53.5 (1649)	19.6 (125)	62.4 (1524)	<.0001
Find variety of flavor choices important, % (<i>n</i>) (<i>n</i> = 4402)	85.4 (3761)	54.6 (566)	94.9 (3195)	<.0001
Find long battery life important, % (<i>n</i>) (<i>n</i> = 4391)	96.7 (4246)	90.6 (933)	98.6 (3313)	<.0001
Find fast battery charge important, % (<i>n</i>) (<i>n</i> = 4394)	76.4 (3358)	78.6 (813)	75.7 (2545)	.0562
Find resemblance to a cigarette important, % (<i>n</i>) (<i>n</i> = 4402)	26.6 (1169)	84.0 (874)	8.7 (295)	<.0001
Switched to current device because of more satisfying hit, % (<i>n</i>)	72.7 (3213)	58.6 (614)	77.1 (2599)	<.0001

E-cig = electronic cigarette.

Comparisons between means were calculated with two-tailed *t* tests and comparisons between percentages were calculated using Chi-square analysis.

nicotine from their device.^{34,35,37,42,43} Hajek et al. determined that e-cig users obtained higher blood nicotine levels from the same e-cig device after practicing with the device for 4 weeks.⁴² In addition, interviews with e-cig users revealed that they found e-cigs to be complex and stated that they had to learn the best vaping techniques.³⁷ As there appears to be a learning curve with e-cig devices, it is not surprising that studies have found that many smokers try e-cigs, most likely FGDs,³¹ but only a small proportion continue to use them.^{7,31,44} Also, it is possible that users who initiate with a FGD (reported to deliver 2–3 ng/ml after 5 minutes)⁴⁵ return to smoking partly because their e-cig delivers a relatively small amount of nicotine when compared to cigarette (reported to deliver 14 ng/ml in the same time).⁴⁵

In regards to device characteristics, the majority of all users thought that long battery life and fast battery charge were important characteristics of an e-cig. Specifically, users of an AGD rated having a variety of flavor choices as important and were more likely to be using a flavored liquid than users of a FGD. This result was not unexpected as it has been reported that more flavor choices are available to users of AGD.²³ Because of the flavor choices associated with AGDs, it is possible that some users transition from their FGD to an AGD because they want to have more flavor choices. In addition, AGD users did not find the device's resemblance to a cigarette to be important, however, the majority of FGD users did. A qualitative interview by McQueen et al. found that e-cig users preferred their first e-cig device to resemble a cigarette³⁷ and that may be why a large number of e-cig users start with a FGD.

It should be noted that the participants completing this survey were experienced and enthusiastic e-cig users. It is expected that these participants may have a more positive view of e-cigs as they are long term users who self-selected themselves to complete the survey. Users of e-cigs who did not complete the survey may have stopped use due to negative experiences, such as experiencing side effects, or they may not be interested in completing the survey. In addition, this survey was cross-sectional in nature and therefore relied on the retrospective report of the participants to detail the transition from their first device to their current device.

Conclusion

This study is the first to illustrate how experienced e-cig users' transition between different device types and to directly compare current users of FGD and AGD. It was found that e-cig users are likely to begin use with a FGD shaped like a cigarette and transition to a larger advanced generation device with a manual button, but not vice versa. The results suggest that e-cig users' transition to advanced generation may be related to their experience that such devices deliver a "more satisfying hit."

Funding

This work was supported by an internal grant from Penn State Social Science Research Institute & Cancer Institute (PI: SJW). JF, SV, JMY, and SH are primarily funded by the National Institute on Drug Abuse of the National Institutes of Health and the Center for Tobacco Products of the US Food and Drug Administration (under award numbers P50-DA-036107-01, P50-DA-036105) and has a research grant funded by Pfizer. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Food and Drug Administration.

Declaration of Interests

JF has done paid consulting for pharmaceutical companies involved in producing smoking cessation medications, including GSK, Pfizer, Novartis, J&J, and Cypress Bioscience.

References

- CASAA. E-cigarette history. 2012. http://casaa.org/E-cigarette_History.html. Accessed November 2014.
- Giovenco DP, Hammond D, Corey CG, Ambrose BK, Delnevo CD. E-cigarette market trends in traditional us retail channels, 2012–2013. *Nicotine Tob Res*. 2014. doi:10.1093/ntr/ntu282.
- McMillen RC, Gottlieb MA, Shaefer RM, Winickoff JP, Klein JD. Trends in electronic cigarette use among U.S. Adults: use is increasing in both smokers and nonsmokers. *Nicotine Tob Res*. 2014. doi:10.1093/ntr/ntu213.

4. Ayers JW, Ribisl KM, Brownstein JS. Tracking the rise in popularity of electronic nicotine delivery systems (electronic cigarettes) using search query surveillance. *Am J Prev Med.* 2011;40(4):448–453. doi:10.1016/j.amepre.2010.12.007.
5. King BA, Alam S, Promoff G, Arrazola R, Dube SR. Awareness and ever-use of electronic cigarettes among U.S. Adult, 2010–2011. *Nicotine Tob Res.* 2013;15(9):1623–1627.
6. Gravely S, Fong GT, Cummings KM, et al. Awareness, trial, and current use of electronic cigarettes in 10 countries: findings from the ITC project. *Int J Environ Res Public Health.* 2014;11(11):11691–11704. doi:10.3390/ijerph111111691.
7. Adkison SE, O'Connor RJ, Bansal-Travers M, et al. Electronic nicotine delivery systems: International Tobacco Control Four-Country Survey. *Am J Prev Med.* 2013;44(3):207–215. doi:10.1016/j.amepre.2012.10.018.
8. Harrell PT, Simmons VN, Correa JB, Padhya TA, Brandon TH. Electronic nicotine delivery systems (“e-cigarettes”): review of safety and smoking cessation efficacy. *Otolaryngol Head Neck Surg.* 2014;151(3):381–393. doi:10.1177/0194599814536847.
9. Dawkins L, Turner J, Roberts A, Soar K. ‘Vaping’ profiles and preferences: an online survey of electronic cigarette users. *Addiction.* 2013;108(6):1115–1125. doi:10.1111/add.12150.
10. Etter JF. Electronic cigarettes: a survey of users. *BMC Public Health.* 2010;10:231. doi:10.1186/1471-2458-10-231.
11. Etter JF, Bullen C. Electronic cigarettes: users profile, utilization, satisfaction and perceived efficacy. *Addiction.* 2011;106(11):2017–2028. doi:10.1111/j.1360-0443.2011.03505.x.
12. Farsalinos KE, Romagna G, Tsiapras D, Kyrzopoulos S, Voudris V. Characteristics, perceived side effects and benefits of electronic cigarette use: a worldwide survey of more than 19,000 consumers. *Int J Environ Res Public Health.* 2014;11(4):4356–4373. doi:10.3390/ijerph110404356.
13. Goniewicz ML, Lingas EO, Hajek P. Patterns of electronic cigarette use and user beliefs about their safety and benefits: an internet survey. *Drug Alcohol Rev.* 2013;32(2):133–140. doi:10.1111/j.1465-3362.2012.00512.x.
14. Vickerman KA, Carpenter KM, Altman T, Nash CM, Zbikowski SM. Use of electronic cigarettes among state tobacco cessation quitline callers. *Nicotine Tob Res.* 2013;15(10):1787–1791. doi:10.1093/ntr/ntt061.
15. Siegel MB, Tanwar KL, Wood KS. Electronic cigarettes as a smoking-cessation: tool results from an online survey. *Am J Prev Med.* 2011;40(4):472–475. doi:10.1016/j.amepre.2010.12.006.
16. King BA, Patel R, Nguyen KH, Dube SR. Trends in awareness and use of electronic cigarettes among U.S. Adults, 2010–2013. *Nicotine Tob Res.* 2014;17(2):219–227. doi:10.1093/ntr/ntu191.
17. Caponnetto P, Polosa R, Russo C, Leotta C, Campagna D. Successful smoking cessation with electronic cigarettes in smokers with a documented history of recurring relapses: a case series. *J Med Case Rep.* 2011;5:585. doi:10.1186/1752-1947-5-585.
18. Bullen C, Howe C, Laugesen M, et al. Electronic cigarettes for smoking cessation: a randomised controlled trial. *Lancet.* 2013;382(9905):1629–1637. doi:10.1016/S0140-6736(13)61842-5.
19. Caponnetto P, Campagna D, Cibella F, et al. Efficiency and safety of an electronic cigarette (eclat) as tobacco cigarettes substitute: a prospective 12-month randomized control design study. *PLoS One.* 2013;8(6):e66317. doi:10.1371/journal.pone.0066317.
20. Biener L, Hargraves JL. A longitudinal study of electronic cigarette use in a population-based sample of adult smokers: association with smoking cessation and motivation to quit. *Nicotine Tob Res.* 2014;17(2):127–133. doi:10.1093/ntr/ntu200.
21. Grana RA, Popova L, Ling PM. A longitudinal analysis of electronic cigarette use and smoking cessation. *JAMA Intern Med.* 2014;174(5):812–813. doi:10.1001/jamainternmed.2014.187.
22. Bagcchi S. E-cigarette market expands online. *Lancet Oncol.* 2014;15(8):e313. www.ncbi.nlm.nih.gov/pubmed/25121182. Accessed January 2015.
23. Zhu SH, Sun JY, Bonnevie E, et al. Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. *Tob Control.* 2014;23(suppl 3):iii3–9. doi:10.1136/tobaccocontrol-2014-051670.
24. Benowitz NL, Goniewicz ML. The regulatory challenge of electronic cigarettes. *JAMA.* 2013;310(7):685–686. doi:10.1001/jama.2013.109501.
25. Trtchounian A, Talbot P. Electronic nicotine delivery systems: is there a need for regulation? *Tob Control.* 2011;20(1):47–52. doi:10.1136/tc.2010.037259.
26. Cobb NK, Byron MJ, Abrams DB, Shields PG. Novel nicotine delivery systems and public health: the rise of the “e-cigarette.” *Am J Public Health.* 2010;100(12):2340–2342. doi:10.2105/AJPH.2010.199281.
27. Brown CJ, Cheng JM. Electronic cigarettes: product characterisation and design considerations. *Tob Control.* 2014;23(suppl 2):ii4–10. doi:10.1136/tobaccocontrol-2013-051476.
28. Rose SW, Barker DC, D'Angelo H, et al. The availability of electronic cigarettes in U.S. Retail outlets, 2012: results of two national studies. *Tob Control.* 2014;23(suppl 3):iii10–16. doi:10.1136/tobaccocontrol-2013-051461.
29. Joyetech. The development path of the joytech. 2014. www.joyetech.com/about/history.php. Accessed November 2014.
30. Herzog B, Gerber J, Scott A. *Equity Research—Tobacco: Vapor World Expo—Key Takeaways.* Wells Fargo Securities; 2014.
31. Giovenco DP, Lewis MJ, Delnevo CD. Factors associated with e-cigarette use: a national population survey of current and former smokers. *Am J Prev Med.* 2014;47(4):476–480. doi:10.1016/j.amepre.2014.04.009.
32. Farsalinos KE, Spyrou A, Tsimopoulou K, Stefopoulos C, Romagna G, Voudris V. Nicotine absorption from electronic cigarette use: comparison between first and new-generation devices. *Sci Rep.* 2014;4:4133. doi:10.1038/srep04133.
33. Vansickel AR, Weaver MF, Eissenberg T. Clinical laboratory assessment of the abuse liability of an electronic cigarette. *Addiction.* 2012;107(8):1493–1500. doi:10.1111/j.1360-0443.2012.03791.x.
34. Vansickel AR, Eissenberg T. Electronic cigarettes: effective nicotine delivery after acute administration. *Nicotine Tob Res.* 2013;15(1):267–270. doi:10.1093/ntr/ntt316.
35. Spindle TR, Breland AB, Karaoghlanian NV, Shihadeh AL, Eissenberg T. Preliminary results of an examination of electronic cigarette user puff topography: the effect of a mouthpiece-based topography measurement device on plasma nicotine and subjective effects. *Nicotine Tob Res.* 2014;17(2):142–149. doi:10.1093/ntr/ntu186.
36. Eissenberg T. Electronic nicotine delivery devices: ineffective nicotine delivery and craving suppression after acute administration. *Tob Control.* 2010;19(1):87–88. doi:10.1136/tc.2009.033498.
37. McQueen A, Tower S, Sumner W. Interviews with “vapers”: implications for future research with electronic cigarettes. *Nicotine Tob Res.* 2011;13(9):860–867. doi:10.1093/ntr/ntt088.
38. Institute TPSCaTR. Penn State Clinical & Translational Research Institute, Pennsylvania State University CTSA, NIH/NCATS Grant Number UL1 TR000127.
39. Foulds J, Veldheer S, Yingst J, et al. Development of a questionnaire to assess dependence on electronic cigarettes in a large sample of ex-smoking e-cig users. *Nicotine Tob Res.* 2014;17(2):186–192. doi:10.1093/ntr/ntu204.
40. Vansickel AR, Cobb CO, Weaver MF, Eissenberg TE. A clinical laboratory model for evaluating the acute effects of electronic “cigarettes”: nicotine delivery profile and cardiovascular and subjective effects. *Cancer Epidemiol Biomarkers Prev.* 2010;19(8):1945–1953. doi:10.1158/1055-9965.EPI-10-0288.
41. Etter JF, Eissenberg T. Dependence levels in users of electronic cigarettes, nicotine gums and tobacco cigarettes. *Drug Alcohol Depend.* 2015 February;147:68–75. doi:10.1016/j.drugalcdep.2014.12.007.
42. Hajek P, Goniewicz ML, Phillips A, Myers Smith K, West O, McRobbie H. Nicotine intake from electronic cigarettes on initial use and after 4 weeks of regular use. *Nicotine Tob Res.* 2014;17(2):175–179. doi:10.1093/ntr/ntu153.
43. Farsalinos KE, Romagna G, Tsiapras D, Kyrzopoulos S, Voudris V. Evaluating nicotine levels selection and patterns of electronic cigarette use in a group of “vapers” who had achieved complete substitution of smoking. *Substance Abuse.* 2013;7:139–146. doi:10.4137/SARTS12756.
44. Pearson JL, Richardson A, Niaura RS, Vallone DM, Abrams DB. E-cigarette awareness, use, and harm perceptions in us adults. *Am J Public Health.* 2012;102(9):1758–1766. doi:10.2105/AJPH.2011.300526.
45. Yan XS, D’Ruiz C. Effects of using electronic cigarettes on nicotine delivery and cardiovascular function in comparison with regular cigarettes. *Regul Toxicol Pharmacol.* 2015;71(1):24–34. doi:10.1016/j.yrtph.2014.11.004.