



Perceptions of non-traditional tobacco products between asthmatic and non-asthmatic college students

Mary P. Martinasek, Robin M. White, Christopher W. Wheldon & Linda Gibson-Young

To cite this article: Mary P. Martinasek, Robin M. White, Christopher W. Wheldon & Linda Gibson-Young (2018): Perceptions of non-traditional tobacco products between asthmatic and non-asthmatic college students, Journal of Asthma, DOI: [10.1080/02770903.2018.1471705](https://doi.org/10.1080/02770903.2018.1471705)

To link to this article: <https://doi.org/10.1080/02770903.2018.1471705>



Accepted author version posted online: 01 May 2018.
Published online: 29 May 2018.



Submit your article to this journal [↗](#)



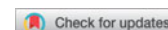
Article views: 45



View related articles [↗](#)



View Crossmark data [↗](#)



Perceptions of non-traditional tobacco products between asthmatic and non-asthmatic college students

Mary P. Martinasek, PhD, RRT, CPH, MPH^a, Robin M. White, PhD, MS, NRN^b, Christopher W. Wheldon, PhD^c, and Linda Gibson-Young, PhD, ARN, PFNP-BC, CN, EAE-CF, AANP^d

^aDepartment of Health Sciences and Human Performance, University of Tampa, Tampa, FL, USA; ^bDepartment of Nursing, University of Tampa, Tampa, FL, USA; ^cBehavioral Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD, USA; ^dAuburn University School of Nursing, Auburn, AL, USA

ABSTRACT

Objective: Electronic nicotine delivery systems (ENDS) use is common among college students and there are perceptions that ENDS are not as harmful as traditional cigarettes. The aim of this study was to examine differences in ENDS use, risk perceptions, and co-occurring smoking behaviors between college students with and without asthma. **Methods:** The study consisted of a cross-sectional online survey with a final sample size of 898 college students. The voluntary participation survey was disseminated to all undergraduate and graduate students at a mid-sized liberal arts university in the Southeast U.S. in the Fall of 2014. **Results:** Approximately 19.7% reported that they had been previously diagnosed with asthma. Forty three percent of participants ($n = 384$) used ENDS in the past 30 days. Equivalent percentages of college students with asthma (46.9%) and college students without asthma (46.9%) have tried ENDS. Overall participants indicated that they perceived ENDS use as less (44%) or equally (38%) as harmful as cigarettes. College students with asthma had 2.85 (95% CI: 1.18–6.89) greater odds of being in the poly-user class, which was characterized by dual use of ENDS, combustible cigarettes, hookah, and marijuana. **Conclusions:** In this study, college students with asthma were similar to their peers with regard to their use of ENDS and related risk perceptions; however, a small subsample of those with asthma exhibited problematic smoking behaviors characterized by dual use of multiple tobacco products including marijuana.

ARTICLE HISTORY

Received 1 January 2018
Revised 15 April 2018
Accepted 28 April 2018

KEYWORDS

Prevention; e-cigarettes; asthma; epidemiology

Introduction

Asthma is a chronic inflammatory airway disease that affects approximately 7.6% to 10.2% of college students in the U.S. (1,2). It is estimated that nearly 21% of people with asthma smoke cigarettes (3); however, as cigarette use has declined, non-traditional tobacco products, such as electronic nicotine delivery systems (ENDS) have gained in popularity. This is particularly evident among young adults aged 15 to 24. Based on U.S. data, young adults demonstrate the greatest prevalence of ENDS use (4.9% to 7.0%), followed by adults (0.6% to 4.2%), and then adolescents (<1% to 3.3%) (4). ENDS were the most commonly used tobacco products in U.S. middle and high school students. Current users are identified as those who have used ENDS in the previous 30 days (5). The Centers for Disease Control and Prevention reported that young adults between the ages of 18 and 24 years demonstrated a higher prevalence of current ENDS use (8.3%) than the overall adult population (4.2%) (2). Lifetime ENDS use

has increased substantially in the last few years, and most often starts in teen or young adult years.

ENDS are not harm-free. In the extant literature, carcinogens were found in several leading brands of ENDS, in addition to ultrafine particulate matter, formaldehyde, acetaldehyde and other toxic cancer-causing chemicals found in secondhand ENDS emissions (6,7). These fine particles in ENDS are delivered to the distal airways and alveoli. Components of ENDS may cause pulmonary toxicity, produce oxidative stress and inflammatory effects, and lead to diminished cell viability (8,9). ENDS have been found to contain chemicals that are irritants and toxic to the lungs, such as formaldehyde, acrolein, and diacetyl (10–14). It has been found that adolescent ENDS users demonstrate increased rates of chronic bronchitis symptoms, which are associated with frequency of product use (9). Inhaling ENDS' vapors is associated with increased secretion of the inflammatory cytokines IL-6 and IL-8 in mouse studies (7). In addition, the

short-term effects of ENDS have demonstrated an immediate decrease of exhaled nitric oxide (eNO), similar to that of traditional cigarettes (15).

In addition to the direct health effects from ENDS use, there is concern that ENDS, which may contain nicotine or various recreational drugs, may serve as a gateway to nicotine addiction, use of other types of tobacco products, or use of illicit drugs (16–18). Bunnell and colleagues found that current ENDS use was positively associated with intention to smoke regular cigarettes among adolescents who have never tried combustible cigarettes (16). In a separate study, those who used ENDS in the past 30 days were more likely to use other tobacco products such as traditional cigarettes, non-cigarette combustibles, smokeless tobacco, and hookah than non-ENDS users (17,19). ENDS may appeal to non-cigarette users, particularly adolescents and young adults, due to their availability in a variety of flavors including fruit and alcohol flavors (20).

It is important to understand how use of one product influences use of another type of product as well as transitions between products, known as poly-tobacco use (21). Both traditional cigarette smoking and hookah smoking have been associated with ever and current use of ENDS in teens (22). For some adolescents, ENDS are used as a smoking cessation aid, or are used in place of cigarettes when indoor smoking is not permitted (23). There is a common perception that ENDS are less harmful than traditional cigarettes, which may facilitate increased use among populations decreasing their use of combustible cigarettes (24).

There are some indications that adolescents with asthma may use ENDS at higher rates, perhaps because of lower perceived harm and wider social acceptance. High school students diagnosed with asthma reported higher ENDS use (12.4%) and hookah use (14.0%) than their peers without asthma (10.2% and 10.9%, respectively) (25). Larsen et al. found that adolescents with asthma were almost 1.8 times more likely to use ENDS than those without asthma (26). These findings have not been replicated with college students.

The aim of this study was to describe differences in ENDS use, risk perceptions, and co-occurring smoking behaviors between college students with and without asthma. We sought to address the following exploratory research questions: how do college students with asthma differ from those without asthma in their (1) current use of ENDS, (2) risk perceptions of ENDS use, (3) patterns of ENDS use, and (4) co-occurring smoking behaviors?

Methods

This study consisted of a cross-sectional online survey to assess self-report measures that determine behaviors and perceptions related to ENDS. Additionally, this study

assessed other product usage, besides ENDS, at an independent liberal arts university in the Southeast U.S. Additionally, the survey asked students if they had been diagnosed by a doctor with asthma. The 28-question survey was disseminated via e-mail and data were collected using QualtricsTM survey instrument. The survey was sent to students attending the university, a mid-sized residential university with a student population of approximately 8000 undergraduate and graduate students. E-mail addresses were obtained from the university's office of Institutional Effectiveness. The survey was sent via e-mail invitation by the primary investigator requesting voluntary participation. Consent for the study was achieved by describing the study in the recruitment e-mail and participants electing to participate by clicking on the survey link. Data were collected for approximately 2 weeks in October of 2014. Incentive to participate included a drawing for one of ten \$50 gift cards. Inclusion criteria consisted of students who were currently attending the University of Tampa. The study was approved by the university's Institutional Review Board prior to study commencement. Survey data were kept on a password protected computer.

Measures

All measures were collected through self-report using an online survey instrument.

Demographic characteristics. Questions were used to describe the sample with regard to gender (male or female) race/ethnicity (non-Hispanic White, non-Hispanic black, Hispanic or Latino, and other race/ethnicities), and sexual orientation (heterosexual, gay/lesbian, bisexual or other).

Health information. Overall health status was measured as poor/fair, average, or excellent. Participants were also asked if they had ever been diagnosed with asthma (Yes or No).

Perceived harm. Two nominal items were used to assess perceived harm from ENDS. The first item focused on perceived harm compared to traditional cigarettes (Less harmful than cigarettes, equally as harmful, More harmful, or Do not know). The second item focused on perceived harm from secondhand exposure (It is safe for others to be around, It is unsafe for others, Do not know).

Electronic Nicotine Delivery Systems (ENDS). Ever use and past 30 day use of an ENDS (electronic cigarette, electronic cigar, or electronic hookah). Several items were used to assess patterns of ENDS use. These included (1) Frequency of Daily Use ("During a typical day, how often do you use an ENDS") (2) Duration of use ranging from "less than one week" to "over one year," as well as a question about (3) primary reason to start using an ENDS with the following response options: "Trying to quit regular cigarettes," "Friends smoking," "Looks cool,"

“I smoke other products and wanted to try it,” or some “other” reason. Current use of ENDS was identified as >1 day during the past 30 days.

Tobacco product use. Participants were asked “Do you currently smoke ...” and were provided with this list of products and asked to check all that apply: Cigars, Hookah, Marijuana. They were separately asked if they currently smoke traditional or regular cigarettes. This was concurrent with survey modeling from the National Youth Tobacco Survey.

Analysis

All statistical analyses were conducted in SAS 9.4. Differences in sample characteristics, ENDS use, and risk perceptions between college students with and without asthma were compared using chi-square analysis. Differences in frequency and duration of ENDS use as well as reasons for initial use were also compared between college students with and without asthma using chi-square test of independence. Zero-order correlations (point biserial coefficients) among current tobacco and marijuana use behaviors for participants who have ever tried an ENDS ($N = 384$) were calculated to examine co-occurrence of smoking behaviors. Latent Class Analysis (LCA)—using PROC LCA in SAS—was used to explore the multidimensional nature of tobacco product use among those with and without asthma. The likelihood ratio chi-square test (G^2), Akaike information criterion (AIC), and Bayesian information criterion (BIC) were used to examine model fit along with the interpretability of 1–5 latent classes. A 4-class model was selected, interpreted, and used to examine latent class prevalence and odds ratios as a function of asthma status.

To ensure that the LCA model was invariant between college students with and without asthma, we ran 2 models. The first model was freely estimated allowing measurement across classes to differ by asthma status. The second model was constrained so that item response and class membership probabilities could not vary between groups. An empirical test of measurement invariance was then performed by taking the difference in G^2 values and degrees of freedom for the constrained and unconstrained models and using chi-square distribution to test for statistical significance. The null hypothesis is that measurement between the groups is equivalent (i.e., invariant), thus rejecting the null hypothesis ($p < 0.05$) indicates that the item response and class membership probabilities vary by asthma status.

Results

The final data sample size consisted of 829 participants after removing 3 participants who did not respond to

75% of the questions and did not respond to the final survey question assessing honesty in their responses. The response rate of the study was approximately 11%. The survey was sent out to nearly 7500 students. Differences in sample characteristics, risk perceptions, and ENDS use between college students with and without asthma are reported in Table 1. The sample was mostly female (70.2%), non-Hispanic White (70.2%), and heterosexual (92.3%). Approximately 19.7% reported that they had been previously diagnosed with asthma by a healthcare provider. The majority of the sample perceived their health status an “average” (51.6%) or “excellent” (41.7%). Close to half (46.5%) of respondents indicated that they had ever used an ENDS. Of those who have tried an ENDS, 42.7% used one or more ENDS products in the previous 30 days. Overall, participants indicated that they perceived ENDS use as less (44%) or equally (38%) as harmful as cigarettes. There was some ambiguity about the harm from secondhand effects, with nearly half (46.8%) of participants unsure about the effects and close to one-third (30.9%) expressing the belief that there are no ill health effects from secondhand exposure. Similarly, 44.3% of respondents perceived ENDS as less harmful than traditional cigarettes.

All sample characteristics were similar for those with and without asthma except for health status, for which a lower proportion of college students with asthma perceived their health as “excellent” ($p = 0.01$). Those with asthma did not differ from their peers without asthma in the proportion that has ever tried or currently use an ENDS product nor in their perceptions of personal or secondhand harm from ENDS use (Table 1).

For those who have ever tried an ENDS ($N = 384$), most did not use it daily (87.9%). Duration of use was less than or equal to one month for nearly half of users (47.7%). Peer influence was the primary reason for initial use (33.3%). These usage patterns did not differ between college students with and without asthma (Table 2).

Current poly-use behaviors are reported in Table 3. Results are restricted to the subsample who have previously tried ENDS ($n = 384$). Tobacco and marijuana use was similar between college students with and without asthma; however, those with asthma had higher prevalence of cigarette smoking, but this difference was not statistically significant (23.7% vs. 14.6%, $p = 0.06$). The pattern of correlations between co-occurring product use was similar between the two groups. Recent ENDS use (i.e., previous 30 days) was positively associated with current cigarette, hookah, and marijuana use for those with and without asthma (although the association between ENDS and hookah use did not reach statistical significance among the students with asthma ($p = 0.07$)).

Table 1. Differences in sample characteristics, risk perceptions, and ENDS use between college students with and without asthma.

	Total <i>n</i> (%)	Asthma <i>n</i> (%) 163 (19.7)	Non-asthma <i>n</i> (%) 666 (80.3)	<i>p</i> value
Gender				0.95
Male	246 (29.8)	48 (30.0)	198 (29.7)	
Female	580 (70.2)	112 (70.0)	468 (70.3)	
Race/ethnicity				0.98
White	582 (70.2)	115 (70.6)	467 (70.1)	
Black	45 (5.4)	8 (4.9)	37 (5.6)	
Hispanic	104 (12.6)	20 (12.3)	84 (12.6)	
Other	98 (11.8)	20 (12.3)	78 (11.7)	
Sexual identity				0.93
Heterosexual	763 (92.3)	151 (93.2)	612 (92.0)	
Gay or lesbian	25 (3.0)	4 (2.5)	21 (3.2)	
Bisexual	25 (3.0)	4 (2.3)	21 (3.2)	
Other	14 (1.7)	3 (1.9)	11 (1.7)	
Health status				0.01
Poor/fair	55 (6.6)	16 (9.8)	39 (5.9)	
Average	428 (51.6)	96 (58.9)	332 (49.9)	
Excellent	346 (41.7)	51 (31.3)	295 (44.3)	
Ever tried ENDS				0.90
Yes	384 (46.5)	76 (46.9)	308 (46.3)	
No	442 (53.5)	86 (53.1)	356 (53.6)	
Used an ENDS in past 30 days^a				0.88
Yes	163 (42.7)	33 (43.4)	130 (42.5)	
No	219 (57.3)	43 (56.6)	176 (57.5)	
Perceived harm of electronic vs. traditional cigarette use				0.58
Less harmful than cigarettes	366 (44.3)	65 (40.4)	301 (45.2)	
Equally as harmful	311 (37.6)	68 (42.2)	243 (36.5)	
More harmful	41 (5.0)	7 (4.4)	34 (5.1)	
Do not know	109 (13.2)	21 (13.0)	88 (13.2)	
Perceived harm of secondhand effects from electronic cigarettes				0.17
It is safe for others to be around	254 (30.9)	42 (26.4)	212 (31.9)	
It is unsafe for others	184 (22.4)	32 (20.1)	152 (22.9)	
Do not know	385 (46.8)	85 (53.5)	300 (45.2)	

^a Asked only of respondents who have ever tried an electronic cigarette, *n* = 384.

Table 2. Comparison of ENDS use between students with and without asthma, *N* = 384.

	E-cig users <i>n</i> (%)	Asthma <i>n</i> (%)	Non-asthma <i>n</i> (%)	<i>p</i>
Frequency of daily use				0.88
Not used everyday	327 (87.9)	67 (89.3)	260 (87.5)	
1 to 5 times	19 (5.1)	3 (4.0)	16 (5.4)	
6 or more times	26 (7.0)	5 (6.7)	21 (7.1)	
Duration of use				0.88
Less than a week	139 (36.8)	24 (32.9)	115 (37.7)	
1 week to 1 month	41 (10.9)	9 (12.3)	32 (10.5)	
1 to 3 months	65 (17.2)	15 (20.6)	50 (16.4)	
6 months to 1 year	66 (17.5)	12 (16.4)	54 (17.7)	
Over one year	67 (17.7)	13 (17.8)	54 (17.7)	
Primary reason to smoke				0.55
Trying to quit smoking regular cigarettes	44 (11.5)	5 (6.7)	39 (12.7)	
Friends smoking	127 (33.3)	25 (33.3)	102 (33.2)	
Looks cool	30 (7.9)	6 (8.0)	24 (7.8)	
I smoke other products and wanted to try it	87 (22.8)	21 (28.0)	66 (21.5)	
Other	94 (24.6)	18 (24.0)	76 (24.8)	

Table 3. Correlation between current smoking behaviors among college students with and without asthma who have ever tried an ENDS product (*N* = 384).

Variable	Total <i>n</i> (%)	Asthma <i>n</i> = 76 (19.8%)	Non-asthma <i>n</i> = 308 (80.2%)	<i>p</i>	1	2	3	4	5
1. E-cig	163 (42.7)	33 (43.4)	130 (42.5)	0.88	—	.26*	.17	.21	.30*
2. Cigarette	63 (16.4)	18 (23.7)	45 (14.6)	0.06	.20*	—	.08	.15	-.06
3. Cigar	40 (10.4)	9 (11.8)	31 (10.1)	0.65	-.00	.11	—	.14	.05
4. Hookah	152 (39.6)	28 (36.8)	124 (40.3)	0.59	.20*	-.06	.14*	—	.13
5. Marijuana	123 (32.0)	29 (38.2)	94 (30.5)	0.20	.26*	.07	.04	.19*	—

Note. Smoking behaviors are measures of current use. Correlation coefficients above the diagonal are for asthmatics and below are for non-asthmatics.

Table 4. Fit statistics for LCA models of tobacco product and marijuana use with 1–5 latent classes.

Number of classes	G ²	AIC	BIC	Entropy
1	185.2	195.2	218.8	1.00
2	41.8	63.8	115.8	0.63
3	35.0	69.0	149.3	0.67
4	17.4	63.4	172.0	0.65
5	8.1	66.1	203.0	0.51

Note. Best fitting model is bolded.

Table 5. Item response probabilities for classes 2, 3, and 4.

	2-Class		3-Class			4-Class			
	1	2	1	2	3	1	2	3	4
E-cig	.24	.77	.34	.88	.24	.63	.82	.95	.09
Cigarette	.04	.25	.04	.32	.04	.04	.69	.15	.03
Cigar	.04	.18	.11	.18	.04	.12	.44	.01	.05
Hookah	.12	.63	.83	.58	.02	.92	.80	.04	.08
Marijuana	.08	.56	.21	.61	.08	.41	.68	.25	.07

Note. Item response probabilities $\geq .50$ are bolded.

Latent class analysis

Four latent classes were selected based on AIC and interpretability (Tables 4 and 5). We considered item response probabilities greater than .50 to reflect a common behavior within that class. Thus, class 1 reflects ENDS and hookah users; class 2 indicates a high “poly user” group using all products except cigars; class 3 encompasses only ENDS use (“ENDS only”); and class 4 (“abstainers”) is characterized by low item response probabilities for all tobacco products and marijuana. The model was invariant between those with and without asthma ($\Delta G^2 = 11.22$; $\Delta df = 20$; $p = 0.95$).

Abstainers were the most prevalent class and did not differ significantly between college students with and without asthma (Table 6). Those with asthma made up a larger proportion of the ENDS only and poly-use classes (17.4% and 11.2%, respectively). When asthma was added as a covariate in the 4-class model, those with asthma had 2.85 (95% CI: 1.18–6.89) greater odds of being in the poly-user class compared to those without asthma who served as the reference group.

Discussion

This study served to compare ENDS use, risk perceptions, and co-occurring smoking behaviors between college students with and without asthma. In particular, we addressed the following exploratory research questions: how do college students with asthma differ from those without asthma in their (1) use of ENDS, (2) risk perceptions of ENDS use, (3) patterns of ENDS use, and (4) co-occurring smoking behaviors?

Regarding use, our study was consistent with published literature in adolescents. We found that college students with asthma exhibited similar patterns of ENDS use compared to those without asthma and did not favor the use of ENDS over other tobacco products (19,25). When assessing for reasons of use, we found that college students with asthma in this study reported similar reasons for ENDS initiation as their peers without asthma, and they were no more likely to use ENDS to quit smoking. This differs from literature on adult traditional cigarette smokers who use ENDS to quit smoking or as a harm reduction (27–30).

Risk perception was assessed as an aim of our study. In particular, we were assessing whether there was a difference based on asthma status. Our study found that college students with asthma felt that ENDS were more harmful than traditional cigarettes as compared to their peers without asthma; however, secondhand vapor was perceived as less harmful by the students with asthma. Despite asthma status, college students are unsure of the harm of secondhand vapor and many are unsure of the harm as related to cigarettes. These results exemplify the general lack of awareness about the current body of knowledge on ENDS. As compared to the literature, young adults express the perception that ENDS are less harmful when compared to traditional cigarettes (31,32). Additionally, recommendations aimed towards current users of ENDS are imperative for college students (5). Fedele et al. compared beliefs about tobacco products between adolescents with and without asthma. Those diagnosed with asthma were more likely to believe that smoking ENDS or hookah “makes people look cool or

Table 6. Latent class prevalence and odds ratios as a function of asthma status.

	Class 1: ENDS and hookah users	Class 2: Poly users	Class 3: ENDS users	Class 4: Abstainers
Prevalence of class membership by asthma				
Asthma				
Yes	6.3	11.2	17.4	65.1
No	13.4	4.11	14.0	68.5
Crude odds ratios and (95% Confidence Intervals)				
Asthma				
Yes	0.50 (0.12–2.13)	2.85 (1.18–6.89)	1.30 (0.50–3.42)	Ref
No	1.00	1.00	1.00	

fit in” and that smoking cigarettes helps to “relieve stress” (25). Adolescent smokers may be likely to view ENDS use as more appropriate than smoking conventional cigarettes because of increasing positive social acceptance regarding ENDS (33).

Pattern of use was a final aim of the study. Understanding dual or poly-tobacco use helps to inform future educational and behavioral change campaigns on this particular campus. Despite the similarities in single product use, college students with and without asthma differ in their dual smoking behaviors. They were over-represented in the latent class of students who reported use of multiple products including ENDS, combustible cigarettes, hookah, and marijuana. For dual use with cigarettes and ENDS with adults, this is a common effort to quit smoking, as seen in some clinical trials (7). We are unable to determine if this is the case with college students and warrants further exploration. Though nationwide smoking is decreasing, high prevalence of non-traditional smoking behaviors and exposures continue in college-aged students. The use of non-conventional tobacco products has increased in availability and readiness. This study identifies almost half of college students who have used ENDS devices in the past 30 days. College students make decisions on risky behaviors daily and the growing perception of harmless activities is often at the center of choice. The risk and harm perception of certain behaviors drives social circles decisions to participate or not in such activities as ENDS or hookah (22,34).

This study has several limitations. First, given the cross-sectional design on a college campus, we limit generalizability to other college campuses. The sample of those with asthma was small so some statistical tests may have been under powered to detect small differences. Moreover, temporal relationships cannot be determined from these findings and further studies are required. Lastly, we measured college students using self-report surveys. It is possible students were not truthful in responses and a proportion of the students attributed social behaviors, in general.

Conclusion

College students diagnosed with asthma use non-traditional tobacco products such as ENDS and hookah despite having an underlying respiratory condition. College students diagnosed with asthma are at risk from the harmful constituents found in ENDS products. Our study found that students with asthma are no different than students without asthma in terms of their motivation and use of ENDS. However, college students with asthma may be more aware of the inhalation of products that may produce negative respiratory health effects and perceived ENDS as being more harmful than students

without asthma. Surprisingly, they did not perceive the secondhand vapor as being any more harmful.

References

1. Akinbami OJ, Moorman JE, Liu X. Asthma prevalence, health care use, and mortality: United States, 2005–2009: US Department of Health and Human Services, Centers for Disease Control and Prevention. Washington (DC): National Center for Health Statistics; 2011.
2. Asthma Surveillance 2016. Available from: <https://www.cdc.gov/asthma/asthmaadata.htm> [last accessed 1 December 2017].
3. Control CfD. Percentage of people with asthma who smoke 2013. Available from: https://www.cdc.gov/asthma/asthma_stats/people_who_smoke.htm [last accessed 1 December 2017].
4. Chapman SLC, Wu L-T. E-cigarette prevalence and correlates of use among adolescents versus adults: a review and comparison. *Journal of psychiatric research*. 2014;54:43–54. doi:10.1016/j.jpsychires.2014.03.005. Cited in PubMed; PMID:24680203.
5. Tsai J, Walton K, Coleman BN, Sharapova SR, Johnson SE, Kennedy SM, et al. Reasons for electronic cigarette use among middle and high school students—National Youth Tobacco Survey, United States, 2016. *Morb Mortal Wkly Rep*. 2018;67(6):196. doi:10.15585/mmwr.mm6706a5.
6. Czogala J, Goniewicz ML, Fidelus B, Zielinska-Danch W, Travers MJ, Sobczak A. Secondhand exposure to vapors from electronic cigarettes. *Nicotine Tob Res*. 2013;16(6):655–662. doi:10.1093/ntr/ntt203.
7. Hajek P, Etter JF, Benowitz N, Eissenberg T, McRobbie H. Electronic cigarettes: review of use, content, safety, effects on smokers and potential for harm and benefit. *Addiction*. 2014;109(11):1801–1810. doi:10.1111/add.12659. Cited in PubMed; PMID:25078252.
8. Lerner CA, Sundar IK, Yao H, Gerloff J, Ossip DJ, McIntosh S, et al. Vapors produced by electronic cigarettes and e-juices with flavorings induce toxicity, oxidative stress, and inflammatory response in lung epithelial cells and in mouse lung. *PloS One*. 2015;10(2):e0116732. doi:10.1371/journal.pone.0116732. Cited in PubMed; PMID:25658421.
9. McConnell R, Barrington-Trimis JL, Wang K, Urman R, Hong H, Unger J, et al. Electronic cigarette use and respiratory symptoms in adolescents. *Am J Respir Crit Care Med*. 2017;195(8):1043–1049. doi:10.1164/rccm.201604-0804OC. Cited in PubMed; PMID:27806211.
10. Tierney PA, Karpinski CD, Brown JE, Luo W, Pankow JF. Flavour chemicals in electronic cigarette fluids. *Tob Control*. 2015; tobaccocontrol-2014-052175. PMID:25877377.
11. Talih S, Balhas Z, Salman R, Karaoghlanian N, Shihadeh A. “Direct dripping”: a high-temperature, high-formaldehyde emission electronic cigarette use method. *Nicotine Tob Res*. 2015;18(4):453–459. doi:10.1093/ntr/ntv080.
12. Pellegrino RM, Tinghino B, Mangiaracina G, Marani A, Vitali M, Protano C, et al. Electronic cigarettes: an evaluation of exposure to chemicals and fine particulate matter (PM). *Ann Ig*. 2012;24(4):279–288. PMID:22913171.
13. Klager S, Vallarino J, MacNaughton P, Christiani DC, Lu Q, Allen JG. Flavoring chemicals and aldehydes in e-cigarette emissions. *Environmental Science & Technology*. 2017;51(18):10806–10813. doi:10.1021/acs.est.7b02205.

14. Shields PG, Berman M, Brasky TM, Freudenheim JL, Mathe EA, McElroy J, et al. A review of pulmonary toxicity of electronic cigarettes in the context of smoking: a focus on inflammation. *Cancer Epidemiol Prev Biomarkers*. 2017;cebp. 0358.2017. doi:10.1158/1055-9965.EPI-17-0358.
15. Marini S, Buonanno G, Stabile L, Ficco G. Short-term effects of electronic and tobacco cigarettes on exhaled nitric oxide. *Toxicol Appl Pharmacol*. 2014;278(1):9–15. doi:10.1016/j.taap.2014.04.004. Cited in PubMed; PMID:24732441.
16. Bunnell RE, Agaku IT, Arrazola RA, Apelberg BJ, Caraballo RS, Corey CG, et al. Intentions to smoke cigarettes among never-smoking US middle and high school electronic cigarette users: National Youth Tobacco Survey, 2011–2013. *Nicotine Tob Res*. 2015;17(2):228–235. doi:10.1093/ntr/ntu166.
17. Chaffee BW, Couch ET, Gansky SA. Trends in characteristics and multi-product use among adolescents who use electronic cigarettes, United States 2011–2015. *PloS One*. 2017;12(5):e0177073. doi:10.1371/journal.pone.0177073. Cited in PubMed; PMID:28475634.
18. Thurtle N, Abouchedid R, Archer JR, Ho J, Yamamoto T, Dargan PI, et al. Prevalence of use of electronic nicotine delivery systems (ENDS) to vape recreational drugs by club patrons in South London. *J Med Toxicol*. 2017;13(1):61–65. doi:10.1007/s13181-016-0583-3. Cited in PubMed; PMID:27599520.
19. Arrazola RA, Singh T, Corey CG, Husten CG, Neff LJ, Apelberg BJ, et al. Tobacco use among middle and high school students-United States, 2011–2014. *MMWR Morb Mortal Wkly Rep*. 2015;64(14):381–385. PMID:25879896.
20. Loukas A, Batanova M, Fernandez A, Agarwal D. Changes in use of cigarettes and non-cigarette alternative products among college students. *Addict Behav*. 2015;49:46–51. doi:10.1016/j.addbeh.2015.05.005. Cited in PubMed; PMID:26046401.
21. Wang B, King BA, Corey CG, Arrazola RA, Johnson SE. Awareness and use of non-conventional tobacco products among US students, 2012. *Am J Prev Med*. 2014;47(2):S36–S52. doi:10.1016/j.amepre.2014.05.003.
22. Barnett TE, Soule EK, Forrest JR, Porter L, Tomar SL. Adolescent electronic cigarette use: associations with conventional cigarette and hookah smoking. *Am J Prev Med*. 2015;49(2):199–206. doi:10.1016/j.amepre.2015.02.013. Cited in PubMed; PMID:25840880.
23. Lee JA, Lee S, Cho H-J. The relation between frequency of e-cigarette use and frequency and intensity of cigarette smoking among South Korean adolescents. *International Journal of Environmental Research and Public Health*. 2017;14(3):305. doi:10.3390/ijerph14030305.
24. 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. Cited in PubMed; PMID:22994631.
25. Fedele DA, Barnett TE, Dekevich D, Gibson-Young LM, Martinasek M, Jagger MA. Prevalence of and beliefs about electronic cigarettes and hookah among high school students with asthma. *Ann Epidemiol*. 2016;26(12):865–869. doi:10.1016/j.annepidem.2016.10.004. Cited in PubMed; PMID:27839657.
26. Larsen K, Faulkner GE, Boak A, Hamilton HA, Mann RE, Irving HM, et al. Looking beyond cigarettes: are Ontario adolescents with asthma less likely to smoke e-cigarettes, marijuana, waterpipes or tobacco cigarettes? *Respir Med*. 2016;120:10–15.
27. Dawkins L, McRobbie H editor(s). *Changing behaviour: Electronic Cigarettes 2017*: British Psychological Society.
28. Levy DT, Yuan Z, Luo Y, Abrams DB. The relationship of e-cigarette use to cigarette quit attempts and cessation: insights from a large, nationally representative US Survey. *Nicotine Tob Res*. 2017. doi:10.1093/ntr/ntx166.
29. Majeed BA, Weaver SR, Gregory KR, Whitney CF, Slovic P, Pechacek TF, et al. Changing perceptions of harm of e-cigarettes among US adults, 2012–2015. *Am J Prev Med*. 2017;52(3):331–338. doi:10.1016/j.amepre.2016.08.039. Cited in PubMed; PMID:28341303.
30. Soule EK, Maloney SF, Guy MC, Eissenberg T, Fagan P. User-identified electronic cigarette behavioral strategies and device characteristics for cigarette smoking reduction. *Addict Behav*. 2018;79:93–101. doi:10.1016/j.addbeh.2017.12.010. Cited in PubMed; PMID:29272713.
31. Smith SY, Curbow B, Stillman FA. Harm perception of nicotine products in college freshmen. *Nicotine Tob Res*. 2007;9(9):977–982. doi:10.1080/14622200701540796.
32. Sutfin EL, McCoy TP, Morrell HE, Hoepfner BB, Wolfson M. Electronic cigarette use by college students. *Drug Alcohol Depend*. 2013;131(3):214–221. doi:10.1016/j.drugalcdep.2013.05.001. Cited in PubMed; PMID:23746429.
33. Pokhrel P, Little MA, Fagan P, Muranaka N, Herzog TA. Electronic cigarette use outcome expectancies among college students. *Addict Behav*. 2014;39(6):1062–1065. doi:10.1016/j.addbeh.2014.02.014. Cited in PubMed; PMID:24630824.
34. Pepper JK, Emery SL, Ribisl KM, Rini CM, Brewer NT. How risky is it to use e-cigarettes? Smokers' beliefs about their health risks from using novel and traditional tobacco products. *J Behav Med*. 2015;38(2):318–326. doi:10.1007/s10865-014-9605-2. Cited in PubMed; PMID:25348584.