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Electronic cigarettes (e-cigarettes) as potential tobacco harm reduction products: Results of an online survey of e-cigarette users

Karyn Heavner, PhD, MSPH (Corresponding author)
University of Alberta, School of Public Health
karynh@aol.com

James Dunworth, BA, PGCE
E Cigarette Direct
james.dunworth@ecigarettedirect.co.uk

Paul Bergen, MSc, MLIS
University of Alberta, School of Public Health
pbergen1@gmail.com

Catherine Nissen, BSc
University of Alberta, School of Public Health
cmnissen@gmail.com

Carl V. Phillips, PhD, MPP
University of Alberta, School of Public Health
cvphilo@gmail.com

Abstract

Electronic cigarettes (e-cigarettes), which surged in popularity in 2008, may be the most promising product for tobacco harm reduction yet. E-cigarettes deliver a nicotine vapor without the combustion products that are responsible for nearly all of smoking's health effects. Other than anecdotal accounts, there is little information about who uses e-cigarettes, and whether people who switch from cigarettes to e-cigarettes experience changes in symptoms caused by smoking. This pilot online survey, conducted by a UK-based online e-cigarette merchant ([E Cigarette Direct](http://E-Cigarette-Direct.com)), investigated e-cigarette use for smoking cessation and changes in health status and smoking caused symptoms. A convenience sample (n=303) was enrolled by e-mail and links on various blogs and forums in May-June 2009. The data were analyzed by independent university researchers at the tobaccoharmreduction.org project.

All respondents previously smoked and 91% had attempted to stop smoking before trying e-cigarettes. Most respondents resided in the USA (72%) and 21% were in Europe. About half (55%) were 31-50, while 32% were >50 years old. Most (79%) of the respondents had been using e-cigarettes for <6 months and reported using them as a complete (79%) or partial (17%) replacement for, rather than in addition to (4%), cigarettes. The majority of respondents reported that their general health (91%), smoker's cough (97%), ability to exercise (84%), and sense of smell (80%) and taste (73%) were better since using e-cigarettes and none reported that these were worse. Although people whose e-cigarette use completely replaced smoking were more likely to experience improvements in health and smoking caused symptoms, most people who substituted e-cigarettes for even some of their cigarettes experienced improvements.

These are highly motivated and passionate e-cigarette users who may have different experiences than average e-cigarette users or smokers, and thus the estimates cannot be extrapolated to all smokers or e-cigarette users. However, the results still suggest that very few e-cigarette users are not using them to replace cigarettes and there are many switchers and current smokers who could have the reported experience. Unfortunately e-cigarettes have been banned in some jurisdictions (e.g., Canada, Victoria (Australia)) where switching from cigarettes to e-cigarettes was documented. The lack of available and legal e-cigarettes may cause some users to resume smoking.

Introduction

Awareness and use of electronic cigarettes (e-cigarettes) has dramatically increased in the past two years. These devices, which are manufactured and sold by several different companies, deliver nicotine by vaporizing a gel composed of water, propylene glycol, flavorings, and nicotine [1]. E-cigarettes deliver nicotine without the products of combustion that are inhaled by smoking cigarettes. Therefore, the health risks are likely similar to those from smokeless tobacco, which has approximately 1% of the mortality risk of smoking [2]. There is likely some remaining risk due to the stimulant effects of nicotine. E-cigarettes are one category of non-combustion nicotine product (others being smokeless tobacco and pharmaceutical nicotine products) that are promising for tobacco harm reduction, the substitution of less harmful nicotine products for cigarettes [3,4].

E-cigarettes are widely available in the United States and Europe and are also available online through many different distributors. E-cigarettes have been banned in some jurisdictions including Canada [5,6] and Victoria (Australia) [6] and are subject to the indoor “smoking” bans in others (e.g., [7]). Although there are legitimate concerns about quality control and product tampering, the importation/sale bans have been criticized by public health advocates because they do not merely address the products’ flaws, but eliminate a promising smoking cessation intervention, offering few realistic options for bringing the product back to market. There is a high likelihood that some people who switched from cigarettes to e-cigarettes but lose access to e-cigarettes will resume smoking.

There are many testimonials and anecdotes on the internet about people switching from cigarettes to e-cigarettes but, to our knowledge, there have been no quantified data published. One online e-cigarette distributor based in the United Kingdom (E Cigarette Direct) conducted an online marketing survey of their e-cigarette users and made their data available to researchers at the University of Alberta School of Public Health for re-analysis. The objectives of this study were to describe e-cigarette users' patterns of cigarette and e-cigarette usage and smoking cessation attempts and to compare health status and smoking-attributable symptoms between people who completely switched from smoking to e-cigarettes, those who partially switched, and those who supplemented cigarette smoking with e-cigarette usage.

Methods

The study was initiated and conducted by [E Cigarette Direct](http://ecigarettedirect.co.uk) (ecigarettedirect.co.uk). A convenience sample was enrolled by sending an e-mail to their consumers and links to the survey were available on their website and on various blogs and online forums. Most of the survey respondents were directed to the survey from an e-cigarette forum. Participants completed an online survey in English on the SurveyMonkey website in May and June 2009. The survey was not anonymous as SurveyMonkey tracks respondents' IP addresses and E Cigarette Direct gave participants the option of providing their e-mail address to be entered in a raffle (as is common practice for marketing surveys). Duplicate IP and e-mail addresses were identified and then these variables were deleted (by JD) prior to sending the data to the University of Alberta research team (tobaccoharmreduction.org) for analysis. Secondary analysis of the anonymized version of the dataset was approved by the Health Research Ethics Board at the University of Alberta.

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The survey assessed respondents' use of cigarettes, e-cigarettes, smoking cessation (including use of pharmaceutical products and switching to e-cigarettes) and changes in smoking-caused symptoms since using e-cigarettes. The dataset included 304 observations, one of which was excluded from all analyses because only country of residence and comments were entered. There were two sets of two observations each which had the same IP address. There were no entries with the same e-mail address. In addition, there were 31 observations with no IP or e-mail address.

All analyses were conducted for the whole sample and for a subsample of the dataset that excluded potential duplicates. The subset excluded all observations without an IP or email address and the observation that was completed last in each of the two sets with the same IP address. The results section focuses on the analysis of the whole sample with differences between the whole sample and the subsample noted. The data were analyzed in SAS (version 9.2, SAS Institute, Cary, North Carolina). Our analysis included frequencies of all variables. Our protocol specified conducting cross tabulations for switching behavior and health status and smoking symptoms. Tests of significance were not conducted as no specific hypothesis were tested and confidence limits are not presented because they tend to mislead most readers into thinking they represent the important source of error. Confidence intervals only convey information about random error, while the greatest potential sources of error in this and other surveys of self-reported health and behavior are non-random.

Results

The frequencies of all survey questions are listed in Table 1. Approximately half of the sample was between the ages of 31 and 50, one-third were more than 50 years old and none were under the age of 18. Nearly three-quarters resided in the US, followed by 17% from the UK. Most of the respondents had been using e-cigarettes for less than six months and all had smoked prior to using e-cigarettes. Most of the respondents had previously tried to stop smoking multiple times. The majority (86%) of respondents had tried pharmaceutical products to quit smoking, nearly two-thirds of whom indicated that these products did not help them to stop smoking. However, most of the sample was able to use e-cigarettes as a complete replacement for cigarettes.

The majority of the respondents indicated that their general health, smoker's cough, ability to exercise, sense of smell and sense of taste were better since starting to use e-cigarettes and none indicated that these were worse when responding to these five questions. However, one participant (whose data was excluded from the rest of the analysis because he/she only entered country of residence and comments) indicated in the comments that his/her health was generally worse since starting to use e-cigarettes but believed that this was due to a concurrent dramatic decrease in caffeine intake. There were only minor differences in the univariate results when possible duplicates were excluded. However, there were a few more substantial differences in the bivariate results in the smaller strata.

On average, respondents who lived in Europe had used e-cigarettes for longer than respondents in the US, but were less likely to use e-cigarettes as a complete replacement for cigarettes (Table 2). There was a positive relationship between the number of times participants had tried to stop smoking and using e-cigarettes as a complete replacement for cigarettes. Most (81%) of the

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respondents who indicated that pharmaceutical products did not help them stop smoking used e-cigarettes as a complete replacement for cigarettes.

Although the majority of respondents reported that their health and smoking-caused symptoms improved since using e-cigarettes, there were some notable trends in which groups were more likely to report improvements (Table 3). Respondents who had been using e-cigarettes for a longer period of time, who had completely replaced their cigarettes with e-cigarettes, or were younger were more likely to report improvements.

Discussion

This sample is mostly composed of people who tried to quit smoking and failed, but then succeeded in switching to e-cigarettes. This contradicts claims put forth by extremist nicotine-abstinence proponents that e-cigarettes are appealing disproportionately to non-smokers and former smokers (supposedly as a result of marketing directed toward these groups, which also represents an unsubstantiated claim). There were only two respondents who indicated that they had quit permanently using pharmaceutical products and it is not known how long ago they quit or whether they would have resumed smoking if e-cigarettes were not available.

Although few people responded that they use e-cigarettes in addition to cigarettes, there are a few noteworthy observations about this group of respondents. Some of these smokers may be supplementing their cigarette smoking with e-cigarette use in places where they are not allowed to smoke. It should be noted that this applies to no more than the 4% of the sample who indicated that they use e-cigarettes in addition to cigarettes. This is one of the main concerns that e-cigarettes opponents have voiced, though the objection to dedicated smokers seeking relief from time and place restrictions involves ethical claims that are seldom made and beyond the present scope [8]. It is not possible to determine whether the total nicotine intake increased for these respondents, as 75% had tried pharmaceutical quit smoking aids and it is possible that they replaced use of pharmaceutical nicotine products with e-cigarettes in places where they cannot smoke. The wording of these questions was rather imprecise (the exact wording of each question appears in Table 1) and may have resulted in misclassification and future surveys should attempt to quantify this by asking respondents to indicate the number of cigarettes that they smoked (per day) before using e-cigarettes and the number that they smoked after starting to use e-cigarettes, as well as when and where they smoke and use e-cigarettes. Approximately half of the few respondents who supplemented their cigarette use with e-cigarettes indicated that their general health was better since starting to use e-cigarettes. This could indicate misclassification (they actually reduced their smoking) or benefits of not suffering nicotine withdrawal symptoms in situations where they are not allowed to smoke.

It is not surprising that none of the respondents indicated that their health got worse after they started using e-cigarettes, as this sample was very interested in, or in other words favourably disposed towards, e-cigarettes (given their participation in the e-cigarette forum and blogs). If people had started using e-cigarettes and their health got worse, they would likely have stopped using/purchasing e-cigarettes and therefore would not have been aware of the survey. Thus the results have to be seen as a proof of concept, but not an estimate of what portion of potential

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users receive the benefits. This study demonstrates that some e-cigarette users replace all or some of their cigarette use for e-cigarettes, and perceive health benefits subsequent to this behavioral change. E-cigarettes (like all other smoking cessation strategies) do not work for everyone, but this survey does demonstrate that e-cigarettes have enabled some people to quit smoking, including some people for whom other methods had proven ineffective. These health benefits will likely be reversed if the trend towards banning e-cigarettes continues and people who replaced e-cigarettes for cigarettes resume smoking.

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Table 1: Preliminary results of the e-cigarette survey

	Whole sample (n=303)		Excluding possible duplicates ¹ (n=270)	
	n	%	n	%
How old are you?				
18 – 30	39	13%	37	14%
31 – 50	165	55%	148	55%
>50	98	32%	84	31%
Missing	1		1	
Please enter your country of residence:				
Europe	62	21%	43	16%
USA	215	72%	206	77%
Canada	8	3%	7	3%
Australia/New Zealand	4	1%	4	1%
Other	9	3%	7	3%
Missing	5	--	3	
Did you smoke before using the electronic cigarette?				
Yes	303	100%	270	100%
No	0	0%	0	0%
Missing	0		0	
How long have you been using electronic cigarettes?				
0 - 5 months	239	79%	210	78%
6 - 12 months	54	18%	51	19%
13 - 18 months	5	2%	5	2%
19 - 24 months	1	0.3%	1	0.4%
>24 months	3	1%	2	1%
Missing	1		1	
Did you try to stop smoking before starting to use the electronic cigarette				
Yes	276	91%	248	92%
No	26	9%	21	8%
Missing	1		1	
If tried to stop smoking before starting to use the electronic cigarette:				
How many times did you try to stop smoking?				
1 - 3 times	95	35%	81	33%
4 - 9 times	120	44%	113	46%
>=10 times	58	21%	51	21%
Missing	3	--	3	--

Table 1: Preliminary results of the e-cigarette survey

	Whole sample (n=303)		Excluding possible duplicates ¹ (n=270)	
	n	%	n	%
Did you ever try to use pharmaceutical products such as nicotine patches or nicotine gum to quit?				
Yes	236	86%	215	87%
No	39	14%	32	13%
Missing	1	--	1	--
If you ever tried to use pharmaceutical products such as nicotine patches or nicotine gum to quit?:				
Pharmaceutical Aids				
Helped me to stop smoking permanently.	2	1%	2	1%
Helped me to stop smoking temporarily (<12 months).	46	20%	39	19%
Helped me to reduce the amount I smoked, but did not help me to stop smoking.	38	17%	34	16%
Did not help me to stop smoking.	144	63%	134	64%
Missing	6	--	6	--
Do you use the electronic cigarette:				
In addition to cigarettes	13	4%	7	3%
As a partial replacement for cigarettes	49	17%	41	15%
As a complete replacement for cigarettes	234	79%	217	82%
Missing	7	--	5	--
Since starting to use the electronic cigarette, do you in general feel your health is:				
Better	267	91%	249	94%
The same	28	9%	17	6%
Worse	0	0%	0	0%
Missing	8	--	4	--
If you had a smoker's cough before using the electronic cigarette, is it now:				
Better	226	97%	210	98%
The same	6	3%	4	2%
Worse	0	0%	0	0%
Not applicable	64	--	52	--
Missing	7	--	4	--
How has your ability to do exercise changed since using the electronic cigarette?				
Better	225	84%	211	88%
The same	42	16%	30	12%

Table 1: Preliminary results of the e-cigarette survey

	Whole sample (n=303)		Excluding possible duplicates ¹ (n=270)	
	n	%	n	%
Worse	0	0%	0	0%
Not applicable	26	--	22	--
Missing	10	--	7	--
How has your sense of smell changed since using the electronic cigarette?				
Better	235	80%	217	82%
The same	58	20%	47	18%
Worse	0	0%	0	0%
Missing	10	--	6	--
How has your sense of taste changed since using the electronic cigarette?				
Better	216	73%	202	77%
The same	78	27%	62	23%
Worse	0	0%	0	0%
Missing	9	--	6	--

1. Possible duplicates are all observations without IP address or e-mail address and 2nd observation in each of 2 sets of observations with the same IP address.

Table 2: Use of electronic cigarettes (n=303)

	How long have you been using electronic cigarettes?(months)				n	Do you use the electronic cigarette:		
	n	0-5	6-12	>12		In addition to cigarettes	As a partial replacement for cigarettes	As a complete replacement for cigarettes
How old are you?								
18 – 30	38	79%	21%	0%	38	5%	16%	79%
31 – 50	165	80%	18%	2%	162	3%	18%	79%
over 50	98	78%	17%	5%	95	6%	15%	79%
Please enter your country of residence:								
Europe	62	69%	27%	3%	62	8%	26%	66%
USA	214	81%	16%	2%	213	3%	13%	84%
Canada	8	100%	0%	0%	8	12%	38%	50%
Australia/New Zealand	4	50%	25%	25%	4	0%	0%	100%
Other	9	89%	11%	0%	9	11%	33%	56%
How long have you been using electronic cigarettes?								
0 - 5 months		--	--	--	234	4%	15%	81%
6 - 12 months		--	--	--	54	6%	28%	67%
>12 months		--	--	--	7	0%	0%	100%
How many times did you try to stop smoking?								
0 times	26	88%	12%	0%	25	8%	20%	72%
1 - 3 times	95	76%	20%	4%	93	3%	27%	70%
4 - 9 times	119	80%	19%	1%	119	3%	14%	82%
>=10 times	58	79%	16%	5%	57	7%	4%	89%
Pharmaceutical aids								
Helped me to stop smoking permanently	2	100%	0%	0%	2	0%	0%	100%
Helped me to stop smoking temporarily	46	72%	26%	2%	45	7%	24%	69%
Helped me to reduce the amount I smoked, but did not help me to stop smoking	38	87%	13%	0%	37	5%	14%	81%
Did not help me to stop smoking	143	75%	20%	5%	142	3%	13%	84%

Table 2a: Use of electronic cigarettes, excluding potential duplicates (n=270)

	How long have you been using electronic cigarettes?(months)				n	Do you use the electronic cigarette:		
	n	0-5	6-12	>12		In addition to cigarettes	As a partial replacement for cigarettes	As a complete replacement for cigarettes
How old are you?								
18 – 30	36	81%	19%	0%	36	6%	17%	78%
31 – 50	148	78%	19%	3%	146	1%	18%	81%
over 50	84	76%	19%	5%	82	4%	11%	85%
Please enter your country of residence:								
Europe	43	58%	37%	5%	43	2%	28%	70%
USA	168	82%	16%	2%	204	2%	13%	85%
Canada	7	100%	0%	0%	7	14%	29%	57%
Australia/New Zealand	4	50%	25%	25%	4	0%	0%	100%
Other	7	86%	14%	0%	7	14%	14%	71%
How long have you been using electronic cigarettes?								
0 - 5 months		--	--	--	207	2%	13%	85%
6 - 12 months		--	--	--	51	4%	27%	69%
>12 months		--	--	--	6	0%	0%	100%
How many times did you try to stop smoking?								
0 times	21	86%	14%	0%	21	5%	19%	76%
1 - 3 times	81	74%	21%	5%	80	2%	25%	72%
4 - 9 times	112	79%	20%	1%	112	2%	14%	84%
>=10 times	51	78%	18%	4%	50	4%	2%	94%
Pharmaceutical aids								
Helped me to stop smoking permanently	2	100%	0%	0%	2	0%	0%	100%
Helped me to stop smoking temporarily	39	72%	26%	3%	39	3%	28%	69%
Helped me to reduce the amount I smoked, but did not help me to stop smoking	34	85%	15%	0%	33	3%	12%	85%
Did not help me to stop smoking	133	74%	21%	5%	132	2%	11%	87%

Table 3: Changes in health status and symptoms since using electronic cigarettes (n=303)

	Since starting to use the electronic cigarette, do you in general feel your health is:			If you had a smoker's cough before using the electronic cigarette, is it now:			How has your ability to do exercise changed since using the electronic cigarette?			How has your sense of smell changed since using the electronic cigarette?			How has your sense of taste changed since using the electronic cigarette?		
	n	Better	Same	n	Better	Same	n	Better	Same	n	Better	Same	n	Better	Same
How old are you?															
18 – 30	38	97%	3%	30	100%	0%	35	94%	6%	48	89%	11%	38	87%	13%
31 – 50	162	90%	10%	129	97%	3%	151	85%	15%	160	84%	16%	162	78%	22%
over 50	94	88%	12%	72	97%	3%	80	79%	21%	94	70%	30%	93	60%	40%
How long have you been using electronic cigarettes?															
0 - 5 months	233	89%	11%	182	97%	3%	210	81%	19%	232	79%	21%	232	72%	28%
6 - 12 months	54	96%	4%	42	98%	2%	51	94%	6%	53	81%	19%	54	78%	22%
>12 months	7	100%	0%	7	100%	0%	5	100%	0%	7	100%	0%	7	100%	0%
Do you use the electronic cigarette:															
In addition to cigarettes	11	55%	45%	9	78%	22%	9	56%	44%	12	42%	58%	12	25%	75%
As a partial replacement for cigarettes	49	78%	22%	32	90%	9%	45	69%	31%	48	62%	38%	49	59%	41%
As a complete replacement for cigarettes	234	95%	5%	190	99%	1%	212	89%	11%	232	86%	14%	232	79%	21%

Table 3a: Changes in health status and symptoms since using electronic cigarettes, excluding potential duplicates (n=270)

	Since starting to use the electronic cigarette, do you in general feel your health is:			If you had a smoker's cough before using the electronic cigarette, is it now:			How has your ability to do exercise changed since using the electronic cigarette?			How has your sense of smell changed since using the electronic cigarette?			How has your sense of taste changed since using the electronic cigarette?		
	n	Better	Same	n	Better	Same	n	Better	Same	n	Better	Same	n	Better	Same
How old are you?															
18 – 30	36	100%	0%	28	100%	0%	34	94%	6%	36	89%	11%	36	86%	14%
31 – 50	147	93%	7%	119	97%	3%	136	89%	11%	145	86%	14%	146	82%	18%
over 50	82	93%	7%	66	98%	2%	70	81%	19%	82	72%	28%	81	62%	38%
How long have you been using electronic cigarettes?															
0 - 5 months	208	92%	8%	167	98%	2%	188	86%	14%	207	82%	18%	206	75%	25%
6 - 12 months	51	98%	2%	40	98%	2%	48	94%	6%	50	82%	18%	51	78%	22%
>12 months	6	100%	0%	6	100%	0%	4	100%	0%	6	100%	0%	6	100%	0%
Do you use the electronic cigarette:															
In addition to cigarettes	7	86%	14%	6	83%	17%	5	60%	40%	7	57%	43%	7	43%	57%
As a partial replacement for cigarettes	41	80%	20%	29	93%	7%	38	71%	29%	40	62%	38%	41	59%	41%
As a complete replacement for cigarettes	217	96%	4%	178	99%	1%	197	91%	9%	216	87%	13%	215	81%	19%

Acknowledgements and Competing Interests

KH, PB, CN and CVP are interested in promoting tobacco harm reduction, and so our scientific selves have a relationship with our policy advocacy selves; the latter motivates our interest in this research. We periodically attempt to persuade corporations with marketing data to make that data available for scientific analysis and publishing; this project could help demonstrate the benefits of such actions. We have numerous contacts and constructive engagements with companies that make tobacco harm reduction products (which include smokeless tobacco companies and makers of e-cigarettes) and hope to receive funding from several of them in the future; it is not clear to us that any of them stands to benefit directly from this research because they generally have better data than the scientific community, but it is possible that we will report information that could be directly beneficial to one or more of them. CVP and his research group (which includes KH, PB and CN) are partially supported by an unrestricted (completely hands-off) grant to the University of Alberta School of Public Health from U.S. Smokeless Tobacco Company. The grantor is unaware of this study, and thus had no scientific input or other influence on it. JD owns 10% of E Cigarette Direct. CVP advises many organizations on tobacco harm reduction, some of which are corporations that could benefit from selling THR products, and is sometimes compensated for this work; he has consulted for U.S. Smokeless Tobacco Company in the context of product liability litigation. KH owns a small amount of stock in Johnson & Johnson.

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