

A Cross Sectional Survey on Health Effects of using Electronic Cigarettes for 2 or More Years

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Abstract

Background: This study was designed to assess the health changes in people who persist in use of electronic cigarettes and to determine if these changes in health were positive or negative. If there is any health impact, to identify how long it takes to see these changes.

Methods: Online surveys were distributed to electronic cigarette social media sites and paper surveys to local stores. There were 572 respondents in a 6 month period from March to August 2015. The survey allowed a breakdown in demographics, including the duration of use of electronic cigarettes. Those who had been using e-cigarettes more than 2 years were analyzed as to changes or resolution of the following health problems: hypertension, asthma, diabetes, acute and chronic bronchitis, recurring respiratory infections and the subjective symptom of dyspnea. Significance values were calculated. Prevalence was calculated and, where possible, compared to the general population.

Results: There was a significant change in reported health issues at 2 points. The first was within the first year after switching, and the second after 2 or more years of use of electronic cigarettes. There was no other annual change that had significance.

In the health issues surveyed there were decreases in cases of hypertension, asthma, acute and chronic bronchitis, recurring respiratory infections, and dyspnea. There was a small sample size of diabetic smokers who had switched. This was not a large enough group to assess significance. However 4 (23.5%) reported resolution and one improved. Another larger study did show significance in control of diabetes.

There were 71 people identified in this survey who had no previous health problems while smoking, and who had used e-cigarettes for 2 years or more. None developed health problems related to use.

Conclusion: Electronic cigarettes have a dramatic and positive effect on the health of those who are able to switch from cigarettes. Significant improvements in health were seen starting within the first year, and another change at 2 years of use. In the case of diabetes, use of electronic cigarettes is superior to either continued smoking or tobacco abstinence to maintain control.

Background

Electronic cigarettes are devices composed of a battery and a tank which stores a reservoir of liquid containing propylene glycol, vegetable glycerin, flavors and, usually, nicotine. The battery heats a coil which vaporizes the liquid which is then inhaled as an alternate nicotine delivery system to combustible tobacco products. Articles appear regularly speculating on the potential for harm of these relatively new devices, or conversely, their potential for harm reduction when used as a substitute or diversion from smoking.

Much of the literature to date focuses on the toxins found in e-cigarette vapor^{1,2,3} and their known consequences in long term exposure. Some of these compare the levels of toxins found in e-cigarettes to the

same toxins found in cigarettes. Some look at how e-cigarette vapor and smoke from tobacco affect human or animal cell cultures^{4,5}. There are studies that look at short term changes in respiratory and cardiovascular function^{6,7,8}. But little information has been gathered to look at what the actual health effects of e-cigarettes have been in those who have been using them for several years. Electronic cigarettes have been available in the modern form since 2007, although the technology is evolving rapidly. Ideally this would give us a nine year window to look for people who have been vaping or dual using and to see how their health has changed. The ideal way to look at this would be to do a prospective study; however there is mounting pressure worldwide to strictly regulate these products, which could unnecessarily restrict those who might benefit from them. The duration of a prospective study could pose the risk preventable harm if these devices are found to be less harmful than cigarettes.

METHODS

The reason for this study was to gather information on vaping health with respect to issues that are directly influenced by smoking. The goals of this study were to:

1. To identify if there was a health benefit from use of electronic cigarettes as a harm reduction tool, and, if so, how long does it take to see measureable and significant benefits
2. Specifically look at hypertension, asthma, diabetes, bronchitis (acute/chronic), and the general categories of dyspnea and recurring respiratory infections.
3. Compare prevalence rates of the reported health issues of respondents as smokers and then as vapers, and compare to the general population for those problems where prevalence is known.
4. To look at those smokers who had no known health effects while smoking, and see what, if any, adverse health effects developed subsequent to starting to use e-cigarettes.

The source of information was an electronic survey distributed through social media to groups of electronic cigarette users and paper surveys to 'vapor' stores. Participation was voluntary and anonymous. Several members of the social medial groups shared the survey with friends or other groups allowing wider dispersal of the survey. Over a period of 6 months, March to August 2015, there were 572 surveys returned. Analysis centered on:

1. Annual milestones in use of electronic cigarettes.
2. Users with less than one year use. (n-142)
3. Users who had 2 or more years of usage (n=283).
4. Specific health events of hypertension, asthma, diabetes, acute and chronic bronchitis, recurring respiratory infections, and dyspnea.

For all groups except the diabetics, statistical significance was calculated relative to the group. For diabetics, resolution of disease was compared relative to the group of diabetics only. Sample size was too small for calculation of statistical significance. Smoking is a recognized contributor to diabetes as a cause of insulin resistance, but there are other more significant causes of diabetes, so this group was looked at separately. One diabetic respondent was included in the diabetic group, but not included in the resolution group, because they reported only an improvement in control.

Results

Limitations: This survey selected only those who had continued use of electronic cigarettes. There was no attempt to assess any reasons that might have caused people to discontinue use.

In order to select what duration of product experience was to be used as the analysis point, the responses were reviewed as to reported health events for each milestone year beginning from less than one year (n=144), one year (n=145), two years (n=170), three years (n=62), and four or more years (n=50). Their reported health events were adjusted as a per annum rate. There were two transition points that had a level of significance, the first was within the first year of switching (p=0.00023) and the second was at the 2 year point in use of electronic cigarettes (p=0.0018). These transition points were used to assess health impacts.

Hypertension

The effect of cigarette smoking on blood pressure as reported in the literature is paradoxical. While it acutely increases cardiac output and peripheral resistance thus causing an increase in blood pressure, some epidemiologic studies have shown that smokers tend to have a lower blood pressure than non-smokers^{9,10}. While other studies show an increase in blood pressure in smokers.^{11,12}

Farsalinos et al showed a positive effect of converting to electronic cigarettes on hypertension⁷. This was a prospective 12 month study that followed 183 people and associated a significant reduction in systolic hypertension in smokers who were successful in converting to vaping.

In this survey subgroup within their first year of use, there were 142 people. Prevalence was 30.1% as a smoker and dropped to 15.5% within the first year of use (p=0.0145)

The respondents showed that of an initial response group of 283 people with 2 or more years use, 92 (32.5%) reported they had been diagnosed with hypertension while smoking. Of these, 43 reported resolution of hypertension after 2 or more years of electronic cigarette use (p=0.0011). This represents a prevalence of 17.3% after converting to electronic cigarettes. Prevalence of hypertension in the general population in the US and Canada is reported to be 29.1%¹³. This survey and the study of Farsalinos seem to indicate that smoking, but not nicotine, is associated with hypertension.

Asthma

Polosa et al⁸ did a prospective study over 2 years following 18 people with asthma who had switched to electronic cigarettes. He showed both a subject and objective improvement in asthma symptoms in his subjects who had switched to electronic cigarettes.

This survey found 26 asthmatics in the one year and under group, and 37 asthmatics in the 2 or more years of use group. Reported asthma decreased to 11 cases in the one year or less (p=0.020), and 19 cases in the 2 year or more group (p=0.0216). Prevalence in the group as smokers was 18.3/13%, and reduced to 7.7/6.67% in the groups (<1year/2 year or more). The prevalence in the population in general is (6.6%).¹⁴ Thus, for those who are successful in switching to electronic cigarettes and maintaining that transition, a return to community levels of asthma should be expected over 2 years.

Diabetes

Smoking has been shown to cause insulin resistance, and is a contributor to diabetes.^{15,16,17,18} In the first 3 years after smoking cessation, there is an increased risk of diabetes¹⁶ presumably related to the weight gain that often accompanies smoking cessation. The benefit of smoking cessation starts to moderate diabetes after 5 years, and does not reach that of the non-smoking population until 20 years after smoking cessation.¹⁵ The mechanism of this affect is not known,¹⁸ however insulin resistance has been shown in both diabetic and non-diabetic smokers. In those who use electronic cigarettes for smoking cessation, the weight gain is less pronounced and for a shorter duration¹⁹. It would be reasonable to assume that if diabetic control is more difficult in smokers who quit, and that this is directly related to the weight gain associated with cessation, then there may be less difficulty in controlling diabetes if electronic cigarettes are used instead of smoking cessation. In the 2 or more year group there were 17 smokers who were identified as diabetics, and who also had more than 2 years of electronic cigarette use. Of those 17 people, there were 4 who reported resolution of diabetes, and one who reported improved control. There were not enough respondents in this category to calculate statistical significance, however, based on predictions of Yeh¹⁶ in smokers who quit, this study should not show a decrease in cases of diabetes. Diabetic prevalence while smoking in this survey was at 5.96%. Prevalence as electronic cigarette users was at 4.56% after 2 years or more of use. This represents a 23.5% reduction starting at 2 years. Prevalence in the general population for diagnosed diabetes is 5.2%²⁰. In the less than one year group, there were 9 diabetics (prevalence = 6.3%), none reported improvement. This survey shows prevalence rates of diabetes in those who stopped smoking by using electronic cigarettes have a modest improvement starting at the 2 year mark. In a study by Farsalinos, et al surveying over 19000 e-cig users worldwide, they found a statistically significant improvement in diabetics at a mean of 10 months use.²¹ This underscores the need for larger and longer term studies, but would suggest that conversion to electronic cigarettes instead of cessation would be preferable for earlier control in this group.

Bronchitis (Acute/Chronic), Recurring respiratory infections, Dyspnea

Smokers have a higher incidence of respiratory infections and symptoms. It has been shown that there is an in vitro effect of electronic cigarette vapor on factors that may influence susceptibility to infection in the respiratory tract in a negative way^{22,23}. These studies looked at cell cultures or the effect on mice.

In this survey there were 18/56 people who had been diagnosed as bronchitis (<1year/2 year or more) (acute or chronic), 27/83 who had recurring respiratory infections, and 74/132 who reported dyspnea. For bronchitis there was a reduction in reported cases to 7/27 (<1year/2 year or more)($p=0.035/0.029$). There was a reduction in cases of recurring respiratory infections to 11/16 ($p<0.00001$). And there was a reduction in dyspnea from 132 to 43 ($p<0.00001$). There is data on prevalence of dyspnea in the population²⁴. Currow, et al, found that 8.9% of the population suffers from dyspnea that affects their daily activity. This represents 52/46% of the survey group. Assuming an 18% rate of smoking this would mean those people represent 8.4% of the population. After use of electronic cigarette use, there were 18/43 people who did not report resolution of dyspnea. This represents 12.6/15% of the survey group. Extrapolating, this represents 2.3/2.7% of the general population. The inference in this finding is that smoking is the primary cause of dyspnea in the

population in general and can be prevented or improved either by smoking cessation, or conversion to electronic cigarettes.

Table 2: Prevalence of health events vs the general population.

	Survey smokers (%) <1 yr/2 or more yr (initial)	Survey Vapers (%) Less than 1 years	Survey Vapers (%) 2 or more years	Population (%)
Asthma	18.3/13	7.7 (p=0.020)	6.67 (p=0.0216)	6.6
Hypertension	30.1/32.5	15.5 (p=0.0145)	17.3 (p=0.0011)	29.1
Diabetes	6.3/5.96	6.3	4.56	5.2
Dyspnea	52 (9.36*)/46 (8.4*)	12.6 (2.3*) (p=<0.00001)	15 (2.7*) (p=<0.00001)	8.9

*extrapolated to general population using 18% cigarette use

No previous health problems while smoking

There were 71 of the 283 previous smokers who had reported no adverse health events while smoking who were also in the 2 year or more group. In this subgroup, there were no reports of new health issues developing while using vapor products.

In another cross sectional survey done in 2014 looking at over 19,000 e-cigarette users²¹, they found improvement in diabetes (40%), hypertension (49.9%), asthma (65.4%), and COPD (75.7%). As measured by stopping medication, there was a resolution of 18.1% of lung disease in this worldwide population survey. This study had a median use of e-cigarettes of 10 months. Only 0.5% of this group had initiated use of e-cigarettes with no previous history of smoking.

Conclusion

This survey showed that there is a significant positive relationship between the prolonged use of electronic cigarettes as a smoking cessation tool, or alternative to smoking tool, and resolution or improvement of several cigarette related illnesses. The benefits become significant within the first year of use and another drop is seen after 2 or more years of use. This seemed to continue through the course of the study. In many cases the reported health events of electronic cigarette users equaled or improved on that of the general population. In the case of all forms of respiratory infections, hypertension, and asthma, there were measurable and significant improvements. For diabetes, this study was too small to show statistical significance. However, there was a decrease in diabetes by 23.5% in the small group of diabetics surveyed. This change was evident in the 2 or more year group. There is an association between the weight gain after smoking cessation and the difficulty in control of diabetes. It has also been shown that the weight gain after initiation of e-cigarettes is less pronounced than that of smoking cessation. This improvement in diabetes was also shown in the Farsalinos study. The implication in this is that health care providers who care for diabetics that smoke should be urging them to switch to electronic cigarettes instead of abstinence in order to more quickly bring their diabetes under control.

In vivo and rat studies that infer compromised immunity related to e-liquid vapor exposure do not seem to have validity when looking at a living population of users. It is important in studies such as those referenced in this paper to not simply look at an effect in isolation from in vivo ability to heal, but also as a comparative to cigarette smoke, and its effect on tissues.

As this and other studies have shown, use of electronic cigarettes improves asthmatics and hypertensives. The prevalence of asthma and diabetes reaches levels similar to the general population, while hypertension resolves to levels lower than the general population.

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DECLARATIONS

Abbreviations:

e-cig, e-cigarette: electronic cigarette

Ethics approval: no human subjects testing or interventions, voluntary respondents anonymous via social media

Consent for publication: No data presented other than original data from my surveys so no additional consent is needed.

Funding, none

I am the sole author. No other contributors

Acknowledgements: none to declare