

Perceived Harm and Addictiveness of E-Cigarette: A Systematic Review

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ABSTRACT

The popularity of electronic nicotine delivery systems (ENDS), also known as e-cigarette, has been growing rapidly in the past years. Therefore, it is also important to explore how e-cigarette users perceive its harm and addiction risk. The aim of this study is to review and determine perceived harm and addictiveness of e-cigarette among e-cigarette users. We conducted a systematic review for published articles in English that had reported about perceived harm and addictiveness of e-cigarette published during year 2008 to 2018. Relevant studies were located through an extensive search from three electronic databases (PubMed, Science Direct, and Cochrane Database of Systematic Reviews) and Google Scholar on October 2018. Key terms used were "perceived harm", "perceived risk", "harm and addictiveness", "belief", "electronic cigarette", "e-cigarette", and "vaping". A result of 88 studies were retrieved and reviewed. After further inspection of references from the collected studies, only 5 selected studies met all inclusion criteria. The final studies consisted of three cross-sectional studies, one longitudinal, and one prospective study. E-cigarette were perceived harmless and less addictive than cigarettes among its users with many predictors associated, including sex, age, race, education, advertisement and health belief for smoking cessation. Compared to non-users, e-cigarette users were significantly less likely to worry about the health risks, either its harm or addictiveness. E-cigarette was perceived harmless and less addictive than tobacco cigarettes. Further study about e-cigarette profile is particularly important to design public health messages that accurately interpret the scientific data on the potential harm and addictiveness of e-cigarette.

Keywords: ENDS, e-cigarette, harm, addictiveness.

INTRODUCTION

The use of electronic nicotine delivery systems (ENDS), also known as vape pens, vaping devices or e-cigarette, is increasing rapidly in some countries^{1,2}. E-cigarette use among adolescents has increased over the years and has surpassed conventional cigarette smoking^{3,4}. E-cigarette also have been advertised as smoking cessation tools in some countries. In public health sector, the long-term effects of e-cigarette use to control smoking have generated both debate and concern due to lack of safety and efficacy data^{5,6}. However, awareness and perceived harm of e-cigarette did not show evidence of promoting smoking cessation at the population level^{7,8}. The tobacco control community is fiercely divided on issues about e-cigarette safety and efficacy for smoking

cessation whether e-cigarette promote youth uptake of cigarette smoking and the regulation⁹.

One of significant concerns of e-cigarette use is addiction. E-cigarette liquid typically contains nicotine, an addictive substance naturally found in tobacco^{10,11}. Other health effect of e-cigarette are also become part of the concern although the long-term health effects of e-cigarette use are largely unknown. Several studies suggest e-cigarette use may cause respiratory harm, increased blood pressure, and can interfere with adolescent brain development. Chemicals found in e-cigarette aerosol can deposit particles such as nickel, tin, and chromium into the lungs, causing local respiratory toxicity¹².

To date, studies indicate that the majority of e-cigarette users are current or

Table I. Inclusion and Exclusion Criteria for The Reviewed Articles

Inclusion Criteria	Exclusion Criteria
1. Published in the English language	1. Review articles, letters and comments
2. Time frame year from 2008 - 2018	2. Article was not based on original research (i.e., the study was a literature review)
3. Report both perceived harm and addictiveness of e-cigarette	
4. Sample were previous or current users of e-cigarette in nation/s of study population	
5. Available in full-text	

former cigarette smokers, that they use e-cigarette to reduce or eliminate cigarette consumption and perceived e-cigarette as less harmful than cigarettes. Even though there is evidence that e-cigarette are effective in reducing or eliminating cigarette consumption, this finding is not consistent^{13,14}. The role of perceptions and beliefs in behavior adoption is critical to understanding modes of intervention and cessation¹⁵. As e-cigarette continue to rise in popularity, it is important to explore how e-cigarette users on perceptions of harm and addiction risk of e-cigarette smoking.

The aim of this study is to review and determine perceived harm and addictiveness of e-cigarette among e-cigarette users in the general population worldwide using data obtained from systematic review. This study may provide insights lead to the design of more effective campaigns that communicate potential harms and addictiveness of e-cigarette by analyzing e-cigarette users' perceptions regarding e-cigarette smoking.

METHODS

This research is a systematic review to find out the perceived harm and addictiveness of e-cigarette among e-cigarette users from several related studies. There were 3 main steps to gain the data; first we identify and select related research about our topic. Second, we assess the retrieved research that met all eligibility criteria. Then third, we made the review and data extraction for each study.

Study identification

Relevant research studies were located through an extensive search from three electronic databases (PubMed, Science Direct, and Cochrane Database of Systematic Reviews) and Google Scholar on October 2018. We conducted a systematic literature search for published articles in English that reported about perceived harm and addictiveness of e-cigarette among e-cigarette users prior to recent years (2008 - 2018).

Preliminary hand search of the literature was completed in order to identify appropriate keywords. Key terms used for the search were as follows: "perceived harm", "perceived risk", "harm and addictiveness", "belief", "electronic cigarette", "e-cigarette", "vaping". Search terms were combined using the operators "AND" and "OR" to ensure that all relevant articles were located. Only articles that had explicitly defined measures those variables of interest were included, with inclusion and exclusion criteria shown in Table I.

Study quality assessment

About 88 studies were initially collected and reviewed: 84 from the initial search strategy and an additional 4 articles were collected from tracking of the literature. After further tracking of references from the retrieved studies only 5 studies were finally analyzed that met all eligibility criteria. Meta-analytic techniques could not be adequately performed because of the limited included

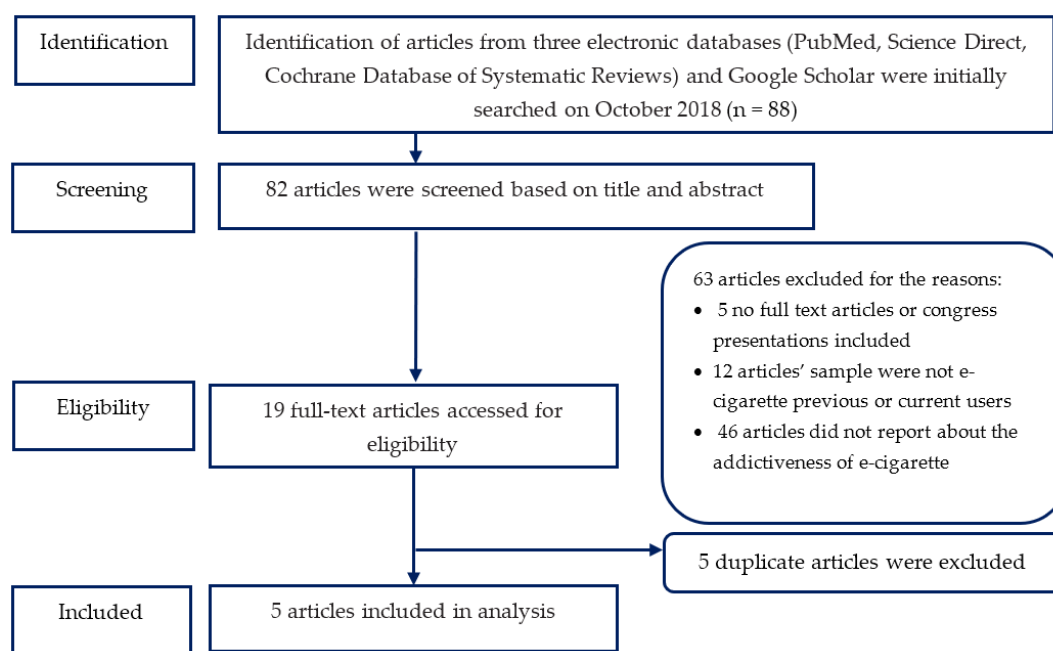


Figure 1. PRISMA Diagram of Retrieved Studies

and heterogeneity in the method and design across studies. However, to facilitate our analysis and discussion, we have grouped the results of the review to examine the comparison of perceived harm and addictiveness of e-cigarette and conventional cigarette also perceptions between e-cigarette users and non users. The PRISMA diagram of retrieved studies (Figure 1).

Data extraction

Data were independently extracted by two independent researchers. Data extraction form included details of study design, research sample, countries, and selection of variables, approach, objectives and the result of each study. Non-agreement or any dissimilarity on the data extraction was resolved by discussion among the authors.

RESULTS AND DISCUSSION

Details of selected studies

The retrieved studies consisted of varied number of population and conducted from different countries (US, Texas, North Carolina, and Minnesota). They were published from different kind of publication

sites. We also found a variety of years of publication within the study, with all study were conducted in recent 5 years (2014 - 2018).

The selected studies consisted of three cross-sectional studies, one longitudinal study and one prospective study. Variation of the respondents of study sample came from wide range of ages and population, start from adolescents aged 14 – 18 years, undergraduate students, young adults and adults aged 18 - 87 years. Most of studies using approach by direct and indirect self-administered questionnaire and interview either by direct or indirect media to the respondents. The methodological characteristics for selected studies of this paper (Table II).

Perceived harm and addictiveness of e-cigarette

The data extraction about study objectives, perceived harm, addictiveness and predictors of e-cigarette use of five selected studies in this systematic review can be seen in Table III. Information of the participants or study’s sample was assessed mostly by self-reported questionnaire with specific kind of question related to perceived harm

Table II. Methodology of Selected Studies

Study	Country	Respondents	Sample size	Method	Data analysis tools
Reinhold <i>et al.</i> , 2017 ¹⁶	US	Students at Midwestern university between the ages of 18–24	6,037	Cross-sectional study	SAS version 9.3
Cooper <i>et al.</i> , 2016 ¹⁹	Texas	6th, 8th and 10th grade students' tobacco use behaviors	3,704	Cross-sectional study	Stata 14.1 College Station, TX
Tan <i>et al.</i> , 2016 ¹⁷	US	Adults aged 18-87 years	527	Longitudinal study	Stata 13 SVY
Rohde <i>et al.</i> , 2018 ¹²	North Carolina	Adolescents aged 14–18 who were susceptible to or had used any tobacco product	69	Cross-sectional study	SPSS version 23
Choi and Foster, 2014 ¹⁸	Minnesota	Young adults (mean age = 24.1 years) from the Minnesota Adolescent Community Cohort	1,379	Prospective study	PC-SAS version 9.2

studies and addictiveness of e-cigarette among the users. Two out of five studies were used to determining perceptions between of e-cigarette and conventional cigarette among e-cigarette users. Meanwhile three other studies were determined the difference of perceived harm and addictiveness of e-cigarette between e-cigarette users and non users.

In Reinhold *et al.*, (2017) study, flavored e-cigarette perceived less harmful than tobacco cigarettes among e-cigarette users with average perceived harm value 4.49 ± 2.12 and 6.15 ± 1.70 , respectively¹⁶. Meanwhile beliefs about benefits (vaping is less harmful than smoking and vaping can help people quit smoking completely), RR = 2.6 and 4.9 respectively, $p < 0.05$, ever users were more likely to agree than never users from Tan *et al.*, (2016) study¹⁷. Choi and Foster (2014) also reported that perceptions of e-cigarette users that agreed about e-cigarette are less harmful than cigarettes had adjusted OR: 2.34

(1.49 - 3.69)¹⁸. E-cigarette users had higher odds (OR = 4.77, 95% CI: 3.19 - 7.15) of reporting that e-cigarette were “not at all” harmful to health compared to non e-cigarette users from Cooper *et al.*, (2016) study¹⁹. Compared to never-users, e-cigarette ever-users were significantly less likely to worry about the health risks of e-cigarette¹².

Furthermore about perceived addictiveness, tobacco cigarettes were perceived as much more addictive than e-cigarette among e-cigarette users¹⁶. Choi and Foster (2014) study also stated that respondents agreed about e-cigarette are less addictive than cigarettes (OR: 1.16, 0.73 - 1.85)¹⁸. Perception of former e-cigarette users on addiction was lower than non users if using vape or e-cigarette everyday (RR 0.2 vs 1.0, $p < 0.01$ ¹⁷). Cooper *et al.*, (2016) study stated e-cigarette users had higher odds (OR = 1.72; 95% CI: 1.12 - 2.65) of reporting that e-cigarette were “not at all” addictive compared to non users¹⁹. Compared to never-users, e-cigarette

Table IIIa. Perceived Harm and Addictiveness of E-Cigarette

Study	Objectives	Perceived harm	Perceived addictiveness	Predictors of perceived harm and addictiveness
Reinhold <i>et al.</i> , 2017 ¹⁶	To investigate if advertising exposure was related to perceptions of harm, addictiveness, and acceptability of use of e-cigarette in places where traditional cigarettes are banned	Flavored e-cigarette (4.49 ± 2.12) is less harmful than tobacco cigarettes (6.15 ± 1.70)	Flavored e-cigarette (5.61 ± 2.17) is less addictive than tobacco cigarettes (6.93 ± 1.58)	Being male, ever having used an e-cigarette, ever having been a smoker, having a mother who smoked, and having seen an advertisement on the internet remained associated with lower perceived harm of e-cigarette use. Only being male and lifetime e-cigarette use were associated with significantly lower perceived addictiveness of e-cigarette
Cooper <i>et al.</i> , 2016 ¹⁹	To understand how e-cigarette are perceived and how these perceptions are associated with their decision whether or not to use them	E-cigarette users had higher odds (OR = 4.77, 95% CI: 3.19 – 7.15) of reporting that e-cigarette were “not at all” harmful to health compared to non e-cigarette users	E-cigarette users had higher odds (OR = 1.72; 95% CI: 1.12 – 2.65) of reporting that e-cigarette were “not at all” addictive compared to non users	None of predictors was statistically significant; therefore, all the models without interactions were used
Tan <i>et al.</i> , 2016 ¹⁷	To assess public beliefs about e-cigarette’ potential harms and benefits	Beliefs about benefits (vaping is less harmful than smoking), ever users were more likely to agree (RR = 2.6, p < 0.05) than never users	Perception of ever users on addiction if using vape or e-cigarette everyday is lower than non e-cigarette users (RR 0.2 vs 1.0, p < 0.01)	Significant correlates for various belief items were age, race, education, and health status

Table IIIb. Perceived harm and addictiveness of e-cigarette

Study	Objectives	Perceived harm	Perceived addictiveness	Predictors of perceived harm and addictiveness
Rohde <i>et al.</i> , 2018 ¹²	To examine adolescents' knowledge and beliefs about e-cigarette risks	Compared to never-users, e-cigarette ever-users were significantly less likely to worry about the health risks of e-cigarette (M = 3.18 vs. M = 3.80, p = 0.031)	Compared to never-users, e-cigarette ever-users were less likely to believe that e-cigarette use would lead to addiction (M = 2.12 vs. M = 3.10, p < 0.001)	Prior combustible cigarette use, mother's education, and addiction risk beliefs about e-cigarette emerged as significant predictors of adolescents' e-cigarette use. This study reveals that knowledge is not associated with adolescent e-cigarette use, risk beliefs do predict use
Choi and Foster, 2014 ¹⁸	To identify the beliefs predicting subsequent use of e-cigarette	Agreed that e-cigarette are less harmful than cigarettes (aOR : 2.34 (1.49 - 3.69))	Agreed that e-cigarette are less addictive than cigarettes (OR : 1.16 (0.73 - 1.85))	Given that young adults are still developing their tobacco use behaviors, informing them about the lack of evidence to support e-cigarette as quit aids and the unknown health risk of e-cigarette may deter young adults from trying these products

RR : relative risk; aOR adjust odds ratio; M : mean

ever-users less likely to believe that e-cigarette use would lead to addiction (Mean 2.12 vs 3.10, p < 0.001)¹².

There were some predictors associated with perceived harm and addictiveness of e-cigarette from the selected studies. Being male, ever having used an e-cigarette, ever having been a smoker, having a mother who smoked, and having seen an advertisement on the internet remained associated with lower perceived harm of e-cigarette use. Only being male and lifetime e-cigarette uses were

associated with significantly lower perceived addictiveness of e-cigarette¹⁶. Age, race, education, and health status also had been significant correlates for various belief items of e-cigarette users¹⁷. Prior combustible cigarette use, mother's education, and addiction risk beliefs about e-cigarette emerged as significant predictors of adolescents' e-cigarette use from Rohde *et al.*, 2018 study¹². Given that young adults are still developing their tobacco use behaviors, informing them about the lack of evidence to support e-cigarette as quit aids

and the unknown health risk of e-cigarette may deter young adults from trying these products¹⁸.

E-cigarette represent a new way to administer substances to the respiratory tract²⁰, using battery power to heat an element and disperse a solution that usually contains nicotine. The dispersion of the solution leads to the create an aerosol that can be inhaled by the user²¹. The main differences between e-cigarette and tobacco cigarettes are expectation to largely determine potential risk discrepancies of the combustion. Other than nicotine, the ingredients of e-cigarette liquids are compounds that have been used extensively in food, pharmaceutical and cosmetic products. There is limited evidence from clinical studies about the effects of inhaling those compounds²².

The safety and risk profile of e-cigarette is particularly important, because e-cigarette have been on the market for few years and the long-term population health effects are unknown²³. Based on our review, most e-cigarette users from the selected study stated that e-cigarette was perceived less harm than tobacco cigarettes. The study highlights the need to design public health messages that accurately interpret the scientific data on the potential harm of e-cigarette and clearly differentiate the absolute from the relative harm of e-cigarette²⁴.

Our review also found that most respondents state that e-cigarette was perceived less addictive than tobacco cigarettes among e-cigarette users. Long-term nicotine addiction is a concern for many health professionals and some smokers themselves²⁵. In 2016, FDA announced its final rule to regulate e-cigarette under the "Family Smoking Prevention and Tobacco Control Act", which outlines options for the regulation of e-cigarette, particularly as they relate to youth and young adults, based on successful smoking policies²⁶. Whilst it is acknowledged that more research is needed into the constituents and long-term effects of e-cigarette, because public deserve an accurate and evidence based in order to inform their

choice²⁷, especially for youth and young adults.

There were some predictors associated with perceived harm and addictiveness of e-cigarette based on our review, including sex, age, race, education, and health belief for smoking cessation. Psychosocial factors like home use of each product, friends' use, positive attitudes toward e-cigarette and participant perception of the harm of e-cigarette were have strongly positive association both with e-cigarette and cigarette use²⁸. Another study state that college students perceive e-cigarette as less addictive than tobacco cigarette is concerning because among adolescents, intention to use cigarette has been found to be highly correlated with perceived addictiveness²⁹. Initial hopes that e-cigarette would be both a less toxic competitor to cigarette and help people to quit smoking have not translated into real-world positive effects. Instead, e-cigarette have simply become another class of tobacco products that are maintaining and expanding the tobacco epidemic²¹.

Potential limitations need to be addressed in interpreting the findings of this review, including heterogeneity of the studies' method made it challenging in summarizing the review. Based on our findings, study about perceived harm and addictiveness of e-cigarette was still limited, especially study from developing countries which also may the factor of this review cannot generally represent the issue in that region. Therefore, we are suggesting more e-cigarette harm and addictiveness study will conduct with an accurate and particular method in the near future. Further research should address the scientific uncertainty surrounding the use e-cigarette^{30,31} and consider means to clearly convey information about its harm and addiction risk.

CONCLUSION

Our review conclude that e-cigarette were perceived less harm and less addictive than tobacco cigarettes among e-cigarette users than non users. There were many

predictors associated with perceived harm and addictiveness of e-cigarette, including sex, age, race, education, advertisement and health belief for smoking cessation. Further study about the safety and risk profile of e-cigarette is particularly important to design public health messages that accurately interpret the scientific data on the potential harm and addictiveness of e-cigarette.

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