

Use of Vaping as a Smoking Cessation Aid: A Review of Clinical Trials

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Purpose: Smoking is a global public health concern, with a significant negative impact on human health and healthcare spending. Vaping, or the use of electronic cigarettes (e-cigarettes), has emerged as a popular alternative to traditional nicotine replacement therapies (NRTs) for smoking cessation. While considered less harmful than combustible cigarettes, the long-term health effects of e-cigarettes (vaping) are unknown. Therefore, this study aimed to identify and provide a comprehensive overview of the performance of vaping in clinical trials.

Patients and Methods: A search was conducted in the ClinicalTrials.gov database on April 14th, 2023, using the search term “smoking cessation, e-cigarettes, NRTs, and vaping”. Inclusion and exclusion criteria were defined to identify relevant clinical trials. Randomized controlled trials (RCTs) and non-randomized clinical trials that evaluated vaping as a therapeutic approach to smoking cessation were included.

Results: A total of 87 clinical trials were identified, of which only seven were related to smoking cessation through vaping as a form of treatment. The primary endpoint was the effect of vaping as smoking cessation, and the secondary endpoints were patients’ abstinence rate, withdrawal symptoms, and adverse events of e-cigarettes. Most of the trials used e-cigarettes as an intervention, with some trials including a combination of e-cigarettes and other NRTs. The trials lasted from 4 weeks to 12 months. The overall results of the trials indicated that vaping was effective in helping smokers to quit. It was also associated with a lower risk of adverse events than combustible cigarettes.

Conclusion: Vaping appears to be an effective method for smoking cessation, and it is associated with a lower risk of adverse events than combustible cigarettes.

Keywords: vaping, e-cigarettes, nicotine, smoking cessation, smoking aid

Introduction

Smoking refers to the act of inhaling and exhaling the fumes of a burning plant, such as tobacco,¹ which is the prepared form of tobacco leaves cultivated for smoking. Smoking is considered to be among the leading risk factors for a number of severe diseases worldwide.^{2,3} In addition, smoking is the second leading cause of early mortality across the globe, significantly contributing to the overall disease burden, particularly in the developing world.⁴ The negative impacts of smoking extend to a loss of productivity and extensive direct healthcare costs. In 2015, the global age-standardized prevalence of daily smoking was 25% in males and 5.4% in females.⁵ Central and Eastern Europe as well as Southeast Asia had the highest prevalence of smoking among males, whereas China, India, and Indonesia accounted for 51.4% of the total number of world smokers.⁶ On the other hand, 27.3% of all female smokers were residents of the United States, China, and India.⁷ The number of daily male smokers was highest in countries with a middle socioeconomic index, while those with a high socioeconomic index had the highest rates of female smokers.⁵

Traditional cigarettes produce around 4800 different chemical compounds upon combustion.⁸ Smoking has been reported to cause a significant reduction in overall health. Besides increased employee absenteeism and marked increases in the utilization of health services, detrimental health effects have increased significantly over the last 50 years.⁹ This observation was confirmed by the Million Women study conducted in the United Kingdom, where women who had

reported being current smokers at the beginning of the survey had a mortality rate approximately three times that of non-smoking women (RR = 2.76; 95% CI, 2.71–2.81) after a 12-year follow-up period.¹⁰ In the same study, around two-thirds of the total mortalities among women aged 50–69 years were attributable to smoking. In a prospective study conducted in British male doctors over 40 years of age, all-cause mortality was more than three-fold greater in current smokers than in non-smokers aged 45–64 years, during the period between 1951 and 1971. This difference continued to increase significantly in the subsequent 20 years of study.¹¹

In recent years, vaping (e-cigarettes) has received significant attention.¹² E-cigarettes are battery-operated devices that heat liquid in order to produce an aerosol that is then inhaled.¹³ As the popularity of vaping grows, especially among adolescents and young adults, substantial concerns have been raised regarding its effects on public health.¹⁴ Vaping has grown in popularity as a result of the perception that e-cigarettes are less harmful than combustible cigarettes.¹⁵ The burning of tobacco in combustible cigarettes emits toxic chemicals that contribute to preventable diseases, such as lung cancer, heart disease, and respiratory disease.¹⁶ E-cigarettes, on the other hand, do not burn tobacco but instead heat a liquid that contains nicotine, flavors, and other additives.¹⁷ Compared to traditional cigarettes, e-cigarettes do not produce tobacco smoke nor contain tar, so they may come with a lower risk of adverse effects.¹⁷ Nevertheless, data on the long-term health effects of e-cigarettes are not yet available, so whether or not they pose a significant health risk when compared to combustible cigarettes remains undetermined.¹⁸

Governments strive to control tobacco use by implementing comprehensive control policies and specific strategies, such as the taxation of tobacco products,¹⁹ establishing smoke-free areas, banning smoking in public areas,^{20,21} as well as conducting smoking cessation interventions in the community and on a nation level.^{22,23} Medically assisted smoking cessation involves the use of a clinically approved approach to relieve nicotine withdrawal symptoms and reduce the cravings caused by nicotine addiction.^{24,25} Over the past few years, vaping has gained considerable attention as an approach for quitting smoking. Nicotine replacement therapies (NRTs), such as nicotine gum, patches, and lozenges, have long been used to assist smokers in quitting.²⁶ However, e-cigarettes have emerged as an alternative to traditional NRTs.²⁷ Vaping can be an effective approach for the treatment of nicotine addiction as its administration reverses withdrawal symptoms and takes away the urge to smoke during the first days of abstinence.

The vape is an Electronic Nicotine Delivery System (ENDS) manufactured to mimic the satisfactory senses of traditional smoking.²⁸ Recent studies have shown that the use of e-cigarettes may increase smoking cessation rates. A US study with 161,054 respondents reported a higher smoking cessation rate in smokers who went on to use e-cigarette users than in those who did not (5.6% vs 4.5%).²⁹ In addition, the WHO considers e-cigarettes to be less toxic than tobacco cigarettes, and the former may thus be proposed as a less harmful alternative.²⁸ This study aims to compile clinical trials on vaping and summarize their findings, including the primary endpoints and treatment outcomes.

Materials and Methods

Search Strategy

The ClinicalTrials.gov database was searched on April 14th, 2023 for all relevant trials. Our aim was to identify all studies examining the use of vaping as a therapeutic approach for the cessation of smoking. Using the website's search engine as a search tool, a search for clinical trials on “smoking cessation, e-cigarettes, NRTs, and vaping” was conducted.

Review of Search Results

In order to identify relevant clinical trials, inclusion and exclusion criteria defined in the research interest were used. Clinical trials that evaluated vaping as a treatment for smoking cessation were included. Studies were excluded if they were not completed or had no results, and they were included if they were completed clinical trials from Phase I to Phase IV that evaluated vaping as a treatment for smoking cessation. The title of the study, study status, type of study, type of intervention, and outcome data were extracted from the relevant trials, and this information is presented in Table 1.

Table 1 List of the Clinical Trials from <https://clinicaltrials.gov>, Updated on 14-04-2023

	Title	Study Year	Conditions	Intervention	Outcome Measures	Number of Participants (n)
1	Smoking Cessation Self-Help for Dual Users of Tobacco Cigarettes and E-Cigarettes ³⁰	2021	Smoking cessation	Behavioral: GENERIC Behavioral: eTARGET	Rate of smoking abstinence Changes in the use of tobacco products	2896
2	Smoking Cessation and Reduction With an Electronic Nicotine Delivery Device (ENDD) ³¹	2013	Nicotine dependence Smoking cessation	Device: E-cigarette 7.2 mg nicotine	Sustained 50% reduction in the number of cig/day at week 24 from baseline (reducers) Sustained 80% reduction in the number of cig/day at week 24 from baseline (heavy reducers)	40
3	Zonisamide/ Bupropion Effects on Switching to Electronic Cigarettes ³²	2022	Smoking cessation	Drug: Zonisamide Drug: Bupropion Other: Halo G6 e-cigarettes	Number of participants that completely switched from combustible cigarettes to Halo G6 e-cigarettes Point abstinence from combustible cigarettes Change in the rewarding effects of smoking combustible cigarettes	26
4	Enhanced E-cigarette Coaching Intervention for Dual Users of Cigarettes and E-cigarettes ³³	2022	Smoking cessation	Behavioral: Enhanced E-cigarette coaching Behavioral: Quitline treatment as usual	Treatment satisfaction and acceptability measured on a scale from 1–6 (very satisfied to very dissatisfied) Treatment engagement: call completion Quit plan development experience Knowledge and beliefs on E-cigarette	110
5	Combination of E-cigarettes and Varenicline for Tobacco Harm Reduction ³⁴	2022	Smoking cessation Harm reduction	Drug: Varenicline Other: E-cigarettes	Number of participants reporting continuous complete switching from cigarettes to Halo G6 Number of participants confirmed (by expired air CO) to have switched from cigarettes to Halo G6 Number of participants reporting point abstinence from smoking cigarettes at 6 months post-switch	25

(Continued)

Table 1 (Continued).

	Title	Study Year	Conditions	Intervention	Outcome Measures	Number of Participants (n)
6	The END Perioperative Smoking Pilot Study ³⁵	2022	Smoking Nicotine addiction Surgery	Behavioral ENDD Drug: NRT	Smoking status on the day of surgery (48-h point-prevalence abstinence), by self-report and confirmed with exhaled carbon monoxide (CO) Frequency of product use: number reporting use daily or most days Report of how helpful the product was for quitting How satisfied the patient was with the product (e-cigarette or patch) How likely the patient would be to recommend the product (e-cigarette or patch) to others Smoking status 8 weeks after randomization (confirmed by exhaled CO) Smoking reduction Number of participants with dual use	30
7	Behavioral and Enhanced Perinatal Intervention for Cessation (B-EPIC): Reducing Tobacco Use Among Opioid Addicted Women ³⁶	2020	Smoking cessation	Behavioral: Behavioral and enhanced perinatal intervention for cessation (B-EPIC) Behavioral	Change in the number of cigarettes smoked per day Change in urine cotinine concentration level Change in electronic cigarette usage per day Change in cigarette dependence Change in electronic cigarette dependence Change in maternal depression over time Change in maternal anxiety over time Change in maternal perceived stress over time	78

Results

Number of Relevant Clinical Trials

As of April 14th, 2023, a total of 87 clinical trials registered on ClinicalTrials.gov were related to smoking cessation through vaping as a form of treatment. Out of these, only seven clinical trials focused on studying the effects of vaping. All seven studies have been completed, and detailed information—the study title, status, condition, intervention, outcome measures, and cohort size—is provided in Table 1. The primary endpoint was the effect of vaping as smoking cessation, and the secondary endpoints were patients' abstinence rate, withdrawal symptoms, and adverse events of e-cigarettes. Most of the trials used e-cigarettes as an intervention, with some trials including a combination of e-cigarettes and other NRTs and/or behavioral intervention. The trials lasted from 4 weeks to 12 months. The overall results of the trials showed that vaping was effective in helping smokers to quit, reducing the number of cigarettes/day, and increasing the rate of smoking abstinence, with gradually reducing nicotine levels. In addition, the use of vaping was associated with a lower risk of adverse events than combustible cigarettes.

Discussion

Smoking is associated with high morbidity, and results of the National Health Interview Survey (NHIS) showed that active smokers had at least one or more smoking-related conditions than non-smokers.³⁷ The prevalence of lung cancer (4.5–9.3%) and chronic obstructive pulmonary disease (COPD), defined as having chronic bronchitis or emphysema (2–4%), is high among both current and former smokers. In particular, cigarette smoking is a major etiology of lung adenocarcinoma. However, the risk associated with smoking is strongly dependent on the specific composition of tobacco smoke, which varies between cigarette types (filtered or not) and brands.³⁸ Despite the lack of a confirmed causative cigarette design, it has been suggested that the use of ventilated filters and higher levels of nitrosamine content are major adenocarcinoma-causing factors [HHS2]. With regard to other cancer types, smoking has been significantly associated with hepatocellular carcinoma, colorectal cancer, and general adverse health outcomes in cancer-affected smokers. On the other hand, there may be a causal relationship between active smoking and tuberculosis as well as tuberculosis-associated mortality. There is a 20–30% increased risk of stroke in individuals exposed to second-hand smoke.³⁹

Overall, exposure to tobacco via the inhalation of smoke and oral exposure to smokeless tobacco both have significant consequences for health.³⁹ This is attributed to the harmful constituents of tobacco products.⁴⁰ For example, the exhaled breath of smokers with COPD contains significantly higher concentrations of aluminium than that of healthy non-smokers.⁴¹ Cadmium is considered one of the major toxic components of tobacco, and it has a long biological half-life. Emphysema and interstitial fibrosis are unfavorable sequelae of exposure to nebulized cadmium materials.^{42,43} Arsenic, present in both oral and inhaled tobacco, results in defects in the relaxation of blood vessels and subsequent cardiovascular disorders.⁴⁴ In addition, exposure to barium in tobacco via oral ingestion or inhalation may lead to hypertension, an increased heart rate, and benign granulomatous pneumoconiosis.³⁹

There are several approaches to smoking cessation, including the gradual reduction of tobacco use, NRT, and prescription medications.⁴⁵ Some people may also benefit from counseling or support groups to help them quit smoking.⁴⁶ As a relatively novel method for smoking cessation, vaping may be particularly attractive to current smokers.⁴⁷ E-cigarettes come in a variety of flavors, which may appeal to smokers who are seeking an alternative to traditional cigarettes in their attempt to quit.⁴⁸ Studies have indicated that e-cigarettes may reduce cravings for combustible cigarettes, in addition to being more satisfying and less addictive.⁴⁹ Furthermore, vaping provides smokers with a viable alternative to conventional smoking, as e-cigarette can be used in indoor spaces where smoking is not allowed.⁵⁰ While several studies have suggested that vaping may not be as effective as established smoking cessation methods,^{51–53} others have suggested e-cigarettes as more effective than NRTs, such as nicotine gum or patches.⁵⁴ Nevertheless, evidence of the long-term efficacy of e-cigarettes for smoking cessation is still limited.

Thus, the effectiveness of vaping as a smoking cessation aid remains a topic of ongoing scientific research.⁵⁵ Some argue that e-cigarettes offer a less harmful and potentially satisfying alternative to conventional cigarettes, conducive to cessation.⁵⁶ Nevertheless, researchers are concerned about the safety of e-cigarettes⁵⁷ and their potential as a gateway to smoking.⁵⁸ Further research into their potential impact on public health is therefore warranted.^{59,60} Meanwhile, healthcare professionals should consider the available evidence and exercise caution when prescribing or recommending

e-cigarettes to patients as an aid for quitting smoking. The individual characteristics, preferences, and risks of each patient should be considered.

Limitations

There are limited long-term data on the safety and effectiveness of vaping as a smoking cessation aid. Most clinical trials conducted in this field have relatively short follow-up periods, typically ranging from a few weeks to a few months. As a result, the long-term effects of vaping on smoking cessation rates, relapse rates, and overall health outcomes may not be fully captured, which could limit our ability to draw definitive conclusions about the sustained effectiveness and safety of vaping as a smoking cessation aid. Additionally, the heterogeneity in design, methodology, and sample size of the clinical trials included in this review may introduce variability into the findings. There is considerable variation in the types of e-cigarettes and vaping products used, the dosages and duration of use, as well as the characteristics of the study populations, which may impact the outcomes observed. This heterogeneity may make it challenging for researchers to compare and synthesize the findings across studies. Furthermore, the rapidly changing landscape of e-cigarettes and vaping products represents another limitation. The regulatory environment, marketing strategies, and product formulations of e-cigarettes are continuously evolving, and these changes may impact the generalizability of findings over time.

Conclusion

The current review suggests that vaping appears to be an effective method for motivating smokers to quit, and it is associated with a lower risk of adverse events than combustible cigarettes. However, there is limited long-term data on the safety and effectiveness of vaping as a smoking cessation aid. Future trials based on longer study periods and the evaluation of other smoking cessation interventions are warranted.

Disclosure

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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