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E-Cigarettes—a review of the evidence—harm versus harm reduction

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ABSTRACT

The World Health Organization estimates there are 1.1 billion cigarette smokers across the globe and that tobacco related deaths number 7 million per year. Electronic nicotine delivery systems (ENDS) are available to contribute options for smoking cessation and include e-cigarettes, e-hookahs, vape pens, mods, and vaping. The growing use of ENDS, or e-cigarettes, in the US and globally across populations is dramatic. Although users may think that e-cigarettes are less harmful than combustible tobacco products, the evidence shows that there are known risks and harms for users. E-cigarettes have varying amounts of toxicants, nicotine, and carcinogens and put the user at risk for lung diseases and COVID-19 similar to smokers. Currently, most governing bodies have not approved e-cigarettes as a smoking cessation tool but do state if a person has failed conventional smoking cessation treatments that e-cigarettes used alone for the short term may help those to quit combustible tobacco and nicotine. A shared decision-making approach should be used when discussing e-cigarettes as a harm reduction tool. More studies and long-term data are needed to assess potential benefits and harms. What is known is that prevention efforts and policy are needed to avoid adolescents and other vulnerable populations from initiating tobacco or e-cigarette use.

KEYWORDS: electronic nicotine delivery systems, e-cigarettes, harm reduction, smoking cessation, nicotine addiction, vaping

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Introduction and hypothesis

Electronic cigarettes, or e-cigarettes entered the global marketplace around 2006.¹ In 2009, the World Health Organization (WHO) coined the term Electronic Nicotine Delivery Systems (ENDS) to denote the many types of e-cigarette devices that contained nicotine.² The term vaping refers to the behavior of using e-cigarettes, similar to smoking when referring to use of combustible tobacco cigarettes. The rapid proliferation of novel ENDS products, along with astute marketing campaigns has dramatically increased vaping across the globe and with it some serious public health concerns. The literature pertaining to ENDS is profuse and often contradictory. Much of the current research addresses the pressing concerns of the epidemic of adolescent use with risk of nicotine addiction, known and potential harms from vaping, overall risks to public health and unanswered questions about the efficacy of e-cigarettes as a harm reduction tool for tobacco smokers. Considering the known harm that tobacco use poses to global health, the questions of safety and efficacy of e-cigarette use for smoking cessation require careful appraisal. Can e-cigarettes be an effective smoking cessation tool, reducing the associated harm of combustible tobacco use, considering the potential, and known risks and harms of e-cigarette use?

Methodology

A careful, intentional review of the international literature was completed. PubMed was searched using the following search string:

(((((("electronic nicotine delivery system") OR ("Electronic Nicotine Delivery Systems"[Mesh])) OR ("e-cigarette")) OR ("electronic nicotine delivery")) OR ("electronic delivery systems")) AND (((("Harm reduction") OR ("Reduce harm")) OR ("Injury reduction")) OR ("Harm minimization")) OR ("Harm Reduction"[Mesh]))) AND (((("smoking cessation") OR ("Smoking Cessation"[Mesh])) OR ("Tobacco Use Cessation Devices"[Mesh]))

Results were further limited to only include articles published in the last 5 years.

Scopus was searched using the following search string: ([electronic nicotine delive OR [electronic nicotine delivery system] AND [harm reduction] AND NOT HIV) AND (([smoking cessation])) AND (risk benefit) AND (LIMIT-TO (SRCTYPE,"j")) AND (LIMIT-TO (AFFILCOUNTRY,"-United States") OR LIMIT-TO (AFFILCOUNTRY,"United Kingdom") OR LIMIT-TO (AFFILCOUNTRY,"Australia")



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OR LIMIT-TO (AFFILCOUNTRY,"Canada") OR LIMIT-TO (AFFILCOUNTRY,"Italy") OR LIMIT-TO (AFFILCOUNTRY,"Germany") OR LIMIT-TO (AFFILCOUNTRY,"Switzerland") OR LIMIT-TO (AFFILCOUNTRY,"New Zealand") OR LIMIT-TO (AFFILCOUNTRY,"South Korea") OR LIMIT-TO (AFFILCOUNTRY,"Poland") OR LIMIT-TO (AFFILCOUNTRY,"Greece") OR LIMIT-TO (AFFILCOUNTRY,"Netherlands") OR LIMIT-TO (AFFILCOUNTRY,"Belgium") OR LIMIT-TO (AFFILCOUNTRY,"Spain") OR LIMIT-TO (AFFILCOUNTRY,"Mexico") OR LIMIT-TO (AFFILCOUNTRY,"China") OR LIMIT-TO (AFFILCOUNTRY,"France")) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"re")) AND (LIMIT-TO (SUBJAREA,"MEDI") OR LIMIT-TO (SUBJAREA,"PHAR") OR LIMIT-TO (SUBJAREA,"NURS") OR LIMIT-TO (SUBJAREA,"MULT")) AND (LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2018) OR LIMIT-TO (PUBYEAR,2017)) AND (LIMIT-TO (LANGUAGE,"English"))

Articles were placed into EndNote and de-duplicated, then further limited to articles published in the last 3 years (2019, 2020, 2021). This produced 280 references to screen. A title and abstract screen were then undertaken to determine whether an article fit the inclusion criteria, which was as follows:

Any article published within the last 3 years which evaluated the harm reduction of e-cigarettes or electronic nicotine delivery systems, particularly when used as smoking cessation devices. The article's country of origin was not limited to the United States. Randomized control trials and larger studies were given preference.

The title and abstract screen narrowed the number of articles for inclusion down to 32. Additional references, some older than 3 years, were identified for inclusion through other sources such as internet searching and backward review of pertinent articles. Articles, statements, and reports by notable organizations were also included, as they gave insight into policy and health recommendations on a global level.

Devices and ingredients of electronic nicotine delivery systems

Electronic cigarettes or ENDS have many names: e-cigarettes, e-hookahs, vape pens, and mods.^{3,4} They come in varied shapes and sizes but have similar components: a cartridge most often with nicotine filled fluid (also called vape fluid), a heating element that vaporizes the fluid, a microprocessor, and a sensor that detects inhalation. The result of the process produces an aerosol with fine particulates.⁴

The first-generation devices brought to market were designed to closely resemble a combustible cigarette.³ Most cigarette smokers found they were not satisfying as a combustible cigarette replacement and did not prove to be successful for sustainable smoking cessation. The first generation e-cigarettes are no longer on the market. The second, third,

and fourth generation devices are accessible commercially in vape/smoke shops, supermarkets, club stores, online, and through illegal market means. In the US and Europe, local governing bodies as well as national agencies have enforced regulations on the sale of ENDS.¹

The fourth generation e-cigarettes entered the marketplace in 2016 and have had the greatest impact on e-cigarette use and vaping behavior. There was an exponential rise in e-cigarette use associated with their arrival, especially in the adolescent population.¹ Some of these devices have modifiable cartridges while others have a standard prefilled "pod." A commercially produced pod contains approximately the same nicotine found in an average pack of combustible tobacco cigarettes; however, nicotine content and effective dose of nicotine per pod can vary widely.⁵ Many of these fourth generation devices can deliver nicotine similarly to smoking cigarettes and levels can peak within 5 minutes of inhaling the aerosol. These devices also vary from earlier generations by having the ability to produce higher temperatures with increased power to better simulate smoking and increase delivery of the aerosol.¹

There are over 400 e-cigarette brands available in stores and online, and over 7000 types of flavors.^{4,6} Flavored vape products have been specifically targeted at teenaged consumers as flavored vaping liquid (or juice) is popular with adolescents.⁷

Other ingredients, such as marijuana and concentrated tetrahydrocannabinol (THC), can be used in all currently available devices, which has led to a sizeable increase in the use of these substances in the adolescent population. A 2018 study from California found 1 in 3 high school students and 1 in 4 middle school students who used e-cigarettes reported using cannabis in their e-cigarette devices.⁸

Statistics

The WHO estimates there are 1.1 billion cigarette smokers across the globe.^{1,9} The morbidity and mortality associated with smoking tobacco is well established and is estimated to be responsible for over 7 million deaths annually worldwide. Smoking rates have remained stable since 2000, with some reductions in smoking in some WHO regions like the USA while increasing in the eastern Mediterranean and African regions.¹

Global data on the numbers of individuals using e-cigarettes are limited. Only about half of the adult population has been surveyed regarding use. Using established epidemiological calculations for assessing use, Jerzynski et al, estimates globally 68 million adults were vaping, in 2020.⁹ In 2019, 4.5% of US adults 18 years and older used e-cigarettes, almost doubling in 2 years. For adults 45 years and older, most were current or former smokers. The highest prevalence of e-cigarette use was found in adults aged 18–24 years, and more than half of these individuals had never smoked cigarettes.¹⁰ These statistics support the idea that a considerable number of these adults were not using ENDS for smoking cessation.

In the US, the fastest growing trend in e-cigarette use is in the adolescent population. In 2017, an exponential increase in adolescent use coincided with the arrival of a sleek fourth generation vaping device onto the global markets.⁴ In the US, there was a 78% increase in current e-cigarette use among high school students and a 48% increase among middle school students. In 2018, 3.6 million middle and high school students had used e-cigarette in the past 30 days, which represented 4.9% of middle schoolers and 20.8% of high schoolers.⁶ In 2019, 17% of Canadian adolescents and 12.6% of UK adolescents reported using e-cigarettes, and the latest data from South Korea, from 2017, reported only 2.0% teen use.⁵

Known and potential harms

There are known and potential risks associated with ENDS use. The list includes nicotine addiction, burns and injury, exposure to inhaled toxicants and carcinogens, second and third hand aerosol pollutants, potential cardiovascular risk, lung injury, severe COVID-related illnesses, and risk of nicotine poisoning in children from ingestion of e-cigarette (or vaping) liquid, especially if flavored.

Most vaping liquids contain propylene glycol and glycerol which comprise 80–94% of the liquid in a commercially produced cartridge. Both propylene glycol and glycerol are known airway irritants, and along with many of the flavoring substances, although deemed safe for consumption, have not been approved for inhalation.¹¹ Exposure to other toxicants, such as metals and metalloids (arsenic, chromium, lead, and nickel), aldehydes, tobacco alkaloids, and hydrocarbons have been well-documented. The amounts absorbed have been shown to be equal or in some cases, greater than levels found in smokers of combustible traditional cigarettes, based on the vaping device.¹¹ Diacetyl is a flavor enhancer and when inhaled, has been linked to *bronchiolitis obliterans* (popcorn lung). It has been identified in some vaping liquids, particularly those with flavoring.^{11,12}

Nicotine is present in most vaping liquids and is a highly addictive, vasoactive substance. Most nicotine used in vaping liquids is extracted from tobacco leaves. However, nicotine can also be synthesized in a lab, but this is more costly and not as potent.¹¹ Nicotine concentrations in vaping liquids can vary significantly based on manufacturer and concentration is dependent on the types of ingredients of the liquid. The concentration can be quite high and therefore can cause toxicity.⁵ Higher blood levels of nicotine have been associated with vaping as compared to combustible tobacco. There are varying formulations of nicotine which also has an impact on absorption. Nicotine salts are a popular preparation and due to a lower pH, are less irritating, making it more tolerable and salts are associated with increased nicotine concentration with higher delivery.⁵

Evidence suggests adolescents who regularly use e-cigarettes are highly susceptible to nicotine addiction and rates of addiction have increased sharply since the arrival of the fourth generation devices. There is mounting evidence that nicotine

can affect adolescent brain development and cognition and is linked to poor impulse control, impaired attention, and learning. There is some evidence of nicotine induced seizure events in adolescents who have vaped. Effectively treating nicotine addiction in adolescents is proving to be quite challenging, as well.¹¹

When considering risks of e-cigarette use to the adolescent population, the vaping of cannabis must be included in the discussion. Significantly increased rates in cannabis vaping have been reported in US teens and is associated with increased blood levels as compared to combustible methods of use. There is also mounting evidence that exposure of the developing adolescent brain to vaped marijuana is associated with neurotoxic changes, such as impaired memory, learning, and cognition.^{8,13,14}

There is growing evidence that adolescent vaping is a gateway to smoking traditional combustible cigarettes. Recent evidence shows teens, who were identified as low risk for smoking cigarettes, are more likely to start smoking after using e-cigarettes than those who have never used, suggesting that an entire cohort of adolescents who would not have initiated tobacco use, will now be exposed to those risks. Increasing numbers of adolescents report dual use, exposing them to the associated risk of this behavior.^{15,16}

In the summer of 2019, a serious vaping-related lung condition emerged as a public health threat in the US. E-cigarette/vaping-associated lung injury (EVALI) was identified and linked to vaping, particularly substances with THC in vitamin E acetate; however, there were cases associated with use of standard vaping liquids.¹⁷ This illness appeared to be isolated to US with rare occurrences in the UK, which had banned vaping oil-based products. EVALI presents with influenza-like symptoms, which can often escalate into severe pneumonia, requiring hospitalization, mechanical ventilation, as well as permanent lung damage.^{2,17}

McAlinden et al looked at the relationship between vaping and COVID-19 and suggests the data represent a greater susceptibility to COVID-19 for vapers, similar to smokers. The researchers associated the increased risk of COVID-related illness in vapers to a proinflammatory response in pulmonary epithelium resulting in an increased risk of pneumonia.¹⁸ Gahia, et al (2020) reported findings from an online survey of more than 4000 adolescents, that those who vaped were 5 times and those who smoked and vaped were 7 times more likely to be diagnosed with COVID-19 than those who did not smoke or vape.¹⁵

The evidence of potential association between cardiovascular risks and e-cigarette use is evolving and often controversial. A cross-sectional retrospective review of the US National Health Interview Surveys (NHIS) of e-cigarette and tobacco users found that daily e-cigarette use was independently correlated with increased risk of myocardial infarct (MI), similar to those who smoked daily. E-cigarette users who had diagnoses of hypertension, diabetes, and/or dyslipidemia were also at increased risk.¹⁹ These findings were re-examined, and found that

the previous models were flawed leading these researchers to conclude there was no compelling evidence that never smokers who used e-cigarette daily were at increased risk of MI.²⁰

Results from a Swedish randomized control study, presented at the European Respiratory Society Congress September 2021, suggested that aerosolized nicotine from vaping was associated with increased thromboembolic activity and disruption of small vessel dilation and relaxation.²¹

Earlier studies have shown conflicting evidence about blood pressure and heart rate reactions associated with e-cigarette use, possibly related to the generation of devices used and nicotine concentration.¹ Overall, the consensus is that vaping alone presents less harm to blood pressure and heart rate regulation than use of traditional combustible cigarettes. However, more head-to-head studies are needed to determine these effects.¹

Dual use of traditional combustible cigarettes and e-cigarettes is quite common. It is estimated that 49.5% of US adults who use e-cigarettes also smoke traditional combustible cigarettes.^{5,19,22} Many individuals dual use intentionally to decrease the number of traditional cigarettes they smoke. Most public health agencies as well as professional societies do not recommend this as even a few cigarettes can cause disease and the potentiation of cardiovascular and lung injury with dual use is still unknown. A study looking at data from the Korean National Health and Nutrition Examination Survey of 7505 men, aged 19 and older, reviewed the association between vaping behavior and cardiovascular (CV) disease. It was found that dual use was practiced by 85% of the participants who vaped. The risk of CV disease was greater in the group who dual used as opposed to never smokers/vapers, and those who smoked traditional cigarettes only. The dual use group also had higher rates of other potent CV disease risk factors, such as high-risk behaviors, obesity, and metabolic syndrome.²² In Alzahrani, et al, study of the NHIS data, they concluded that dual use was associated with higher risk of MI than either traditional combustible cigarettes use alone, or e-cigarette use alone.¹⁹ There has been little research on use of e-cigarettes and cancer risk and those studies that have been carried out had small sample sizes and limited generalizability.¹

Although some carcinogens are present in vape liquid, there is evidence that heated vs burned (or combustible) inhalation of these substances may be less harmful.⁵ There appears to be less exposure to fewer harmful substances with e-cigarettes use when compared to traditional combustible cigarettes and for these reasons e-cigarettes are most likely less harmful than traditional combustible cigarettes, however, long-term risks still need to be assessed.^{1,5}

E-cigarettes and harm reduction

The data on e-cigarettes as an effective and safe harm reduction strategy for users of traditional combustible cigarettes, are complicated and often contradictory. Although there has been

some recent evidence that supports the use of e-cigarettes for smoking cessation, there is also evidence that ENDS use may be associated with other worrisome behaviors. Use of e-cigarettes may persist after smoking cessation, cigarette use relapse may be a risk, dual use is common, and the full extent of risks is still largely unknown, especially with the frequent arrival of novel devices to the marketplace and vast variations in vape liquid, ingredients, and nicotine concentration.⁵

Dual use is a widespread practice and many adults dual use with the belief it is reducing their overall risk.^{5,23} In a recent study reviewing most common methods used for smoking cessation, it was found that 75% of adult smokers used multiple methods, concurrently, to stop smoking. The most common method was reducing the number of cigarettes smoked. E-cigarettes were used more often as a substitute for some traditional cigarettes (dual use) than traditional nicotine replacement therapy (NRT) products.²⁴ A study out of Italy looked at harm reduction and smoking cessation in smokers, e-cigarette users and dual users, over a 6-year period. Harm was measured by self-report of health status, hospital admissions, and possible smoking related disease (PSRD). The results showed no improvement in smoking cessation rates or harm reduction in e-cigarette or dual users. The evidence did suggest that a complete switch from traditional cigarettes to e-cigarettes may support abstinence from traditional smoking, but more research is needed.²⁵ Jackson looked at 413 individuals enrolled in the UK's Smoking Toolkit Study, to examine dual use of traditional cigarettes with over the counter (OTC) NRT vs e-cigarettes. They found that dual use with e-cigarettes was associated with greater reduction of traditional cigarette consumption than dual use with OTC NRT. They add that dual use with e-cigarettes may discourage a small percentage of smokers from trying complete cessation of tobacco use.²⁶

There is an increasing body of evidence that e-cigarettes may be an effective smoking cessation tool, reducing harm to users of combustible tobacco.²⁷⁻³¹ Hajek, et al, in the UK, found that current smokers who used e-cigarettes for smoking cessation had double the quit rates compared to nicotine replacement therapies (NRT's)—when both were accompanied with behavioral supports, 18.8% compared to 9.9%, respectively, at 12 months. The e-cigarette cohort also reported less phlegm and cough than those using NRT. It is important to note, however, that 80% of e-cigarette users were still using them at 12 months vs 9% of NRT users.^{28,29} Myers-Smith, et al, studied smokers in a London, UK Stop Smoking Service, who identified as wanting to quit but had been unsuccessful in past attempts. The results found e-cigarettes were associated with significantly greater reduction and quit rate than traditional NRT and had sustained abstinence at 6 months.³¹

Data from a French study examined smoking cessation and relapse rates and found significantly increased quit rates for e-cigarette users; however, they also found increased rates of relapse after 2 years.²⁷ Kalkhoran, Chung, and Rigotti found that smokers who used e-cigarettes daily, in contrast to

intermittent use, had greater success for prolonged abstinence of 2 years or longer, than those who did not use e-cigarettes.³²

A study comparing nicotine dependence between cigarette smokers and those who had transitioned to a popular fourth generation device found that dependence decreased for those who had successfully switched from combustible cigarettes to the e-cigarette over a 3-month period, regardless of nicotine concentrations of the products.³³

In a recent update of a Cochrane systematic review, Hartman-Boyce, et al looked at 59 completed studies on e-cigarettes for smoking cessation which included 29 randomized controlled trials (RCTs) and represented more than 12,000 participants.³⁰ These studies compared e-cigarette's effectiveness in smoking cessation as compared to NRT, varenicline, nicotine-free e-cigarettes, behavioral support, or no smoking cessation support. The reviewers looked specifically at the number of individuals who had stopped smoking for 6 months or more and at adverse effects for 1 week or more. The authors concluded with moderate certainty that e-cigarettes aid more individuals to stop smoking for 6 months or longer than NRT or nicotine-free e-cigarettes and may, with less certainty, be more helpful than behavioral support or no support. In addition, there did not seem to be an association with serious unwanted or adverse effects. Due to the rapidity and abundance of new data and the level of concern from a public health perspective, the Cochrane Collaboration has decided this will be a "living systematic review," committing to monthly literature reviews and updated evidence as it becomes available.³⁰

The harm from traditional combustible cigarette use is well-known and is associated with many chronic diseases and is the etiology of most cases of COPD. Smoking cessation for those with COPD and other chronic diseases is essential for effective treatment and improved function. Polosa, et al, in Catania, Italy, monitored long-term health indicators in individuals with COPD who either reduced or completely ceased tobacco use with e-cigarette use, over a 3-year period. They found that those who either switched completely from tobacco to e-cigarettes, or reduced tobacco use with e-cigarettes had improved their COPD related symptoms (cough, phlegm production, and shortness of breath), exercise tolerance, overall quality of life, and decreased their rate of COPD exacerbations.³⁴ Kalkhoran, Chung, and Rigotti looked at longitudinal data from the US Population Assessment of Tobacco and Health Study (PATH) particularly pertaining to smokers with chronic health conditions using e-cigarettes. They found that most of the individuals who initiated e-cigarettes did so with the intention to quit cigarettes. It was also found that on a population level, e-cigarette use in those with chronic disease was associated with increased smoking quit rates and continued abstinence from smoking.²³

A few studies have presented conflicting evidence about the efficacy of e-cigarettes as a smoking cessation strategy. Patil et al reviewed 13 U.S.-based studies and concluded that there was no significant association between e-cigarette use and smoking

cessation.³⁵ The authors suggest that there may be differences in cessation rates and types of devices used, some being more effective than others.³⁵ A South African study, where e-cigarettes are schedule 3 substances dispensed in pharmacies, looked at smoking reduction and cessation rates for never and ever users of e-cigarettes. They found that, although most ever users believed that e-cigarettes would aid in quitting, the rates of sustained smoking cessation were less in the ever use cohort as compared to never e-cigarette users. The rates of relapse were also higher in the ever user group.³⁶ A longitudinal study of >3000 former tobacco smokers surveyed in the US Population Assessment of Tobacco and Health (PATH) found that vaping 12 months or more after quitting traditional combustible cigarettes was associated with smoking relapse.³⁷

Limited data exist on the use of e-cigarettes as harm reduction strategy during pregnancy. DeVito, et al, reviewed 7 studies and found some preliminary data that e-cigarette use may be associated with poor perinatal outcomes, such as small for gestational age; however, there was insufficient data and small sample sizes which limited certainty of findings.³⁸ Due to the lack of reliable evidence, there is broad consensus across public health agencies and professional organizations globally, that use of e-cigarettes should be avoided during pregnancy, regardless of smoking status and not be used as a harm reduction tool at this time.³⁸⁻⁴⁰

The existing evidence suggests exposure to toxicants and carcinogens from e-cigarettes is most likely less harmful than from combustible tobacco products. It is important to note that the evidence does not indicate that e-cigarettes are harmless. The evidence is mounting that for some long-term users of traditional combustible tobacco, e-cigarettes may be helpful in smoking cessation and therefore, reducing harm. A well-informed, shared decision-making approach about the use of e-cigarettes for smoking cessation, weighing risks and benefits may be a tool for health care providers to consider. Consideration of harm reduction in those at substantial risk from tobacco use, such as long-term users, those with chronic disease, may make e-cigarettes a suitable approach to smoking cessation in those who have failed other methods. More high quality RCTs are needed to further investigate the efficacy of e-cigarettes as a reliable and safe harm reduction strategy. Monitoring and evaluation of short term and most importantly long-term risks and harms is imperative to expand knowledge and improve safe practice.

Health policy and regulations

The two main competing perspectives that influence vaping policy are effective harm reduction for smokers and protection from harm for nonsmokers, and particularly youths, pregnant women, and bystanders.^{41,42}

A large-scale study in Italy of over 15,000 individuals between 2014 and 2018 in an annual face to face survey, were asked about tobacco and e-cigarette use. Among smokers using

e-cigarettes to quit, a greater number of them relapsed and restarted smoking cigarettes than those who were successful at quitting. Their conclusion was the overall impact of e-cigarette use was unfavorable from a general population health view and suggested that without prohibition of e-cigarette sales to non-smokers, these devices may increase use of traditional combustible cigarette use rather than cause meaningful harm reduction.⁴³

The World Health Organization considers e-cigarettes harmful due to exposure to carcinogens and nicotine, and should be avoided particularly by children, nonsmokers, and vulnerable populations. The WHO does not endorse e-cigarettes for smoking cessation.⁴⁰ The CDC describes the evidence of e-cigarettes for smoking cessation as “suggestive but insufficient,” however, says that for those who have failed conventional FDA approved treatment methods, e-cigarettes may be suitable and stresses that these products should be used exclusively, without dual use and for the short-term, defined as 6–12 months.³⁹

The most recent policy position by the European Respiratory Society (ERS), in 2020, firmly states that e-cigarettes, while most likely less harmful than combustible tobacco use, is still harmful and therefore, they cannot endorse any product that is harmful to lungs and health.⁴⁴ The ERS position identifies the tobacco industry as a powerful global influence, through funding research and promotion, on policy and regulation. The ERS encourages public health agencies and professional organizations to support independent research and policy development.⁴⁴

According to the WHO, 32 countries have banned sales of ENDS, 79 have at least 1 restriction on sales, marketing, or public use while 84 countries have no current regulation on e-cigarettes.⁴⁰ In the US, the first federal regulation was not enacted until 2016, a full 10 years after the arrival of e-cigarettes.^{41,42} As identified by the ERS and other agencies, the tobacco industry is entangled in the international e-cigarette market, applying the power of their influence on regulations in many countries.^{41,42,44} The global health community must be aware of these effects in influencing policy, regulation and ultimately, public health, globally.

As of now the only country that has endorsed e-cigarettes as a smoking cessation tool is the UK⁴² The policy decision reached by the Public Health Service (PHS), in 2017, was to place harm reduction for current smokers as their prime concern.⁴² Per the UK's government website, they provide statistics to support the success of e-cigarettes as an effective smoking cessation tool. They report that e-cigarettes were the most popular smoking cessation aid used by 27.2% of smokers trying to quit; in 2017 50,000 smokers quit using e-cigarettes as an aid, and those visiting local Stop Smoking Services who used e-cigarettes as an aid, had the highest quit rates of 59.7% in 2019 and 74% in 2020.⁴⁵

The UK's Smoking and Alcohol Toolkit Study (STS/ATS) is a longitudinal project gathering information about tobacco (including e-cigarettes) and alcohol related behaviors and

attitudes. It was recently expanded beyond Britain to Wales and Scotland and will continue to gather data through 2024. Data from this study promise to provide important evidence that will inform practice and policy around efficacy and harm reduction benefits of e-cigarettes.⁴⁶

The E-Cigarette Summits are yearly gatherings of concerned health professionals, researchers, scientists, and policy makers. These Summits provide a forum to present the current evidence and policies which are discussed and debated with the intent of sharing research, opinion, and perspectives from colleagues across the globe to consider the potential risks and benefits of e-cigarettes. The Summits are annual, with the first summit in London, 2013 and in Washington, DC, since 2018. It is billed as one of the most influential international public health forums, impacting policy and regulations affecting the world's population. Recordings from the proceedings are available after the Summits at their website.⁴⁷

Summary and conclusions

E-cigarette use has been identified as a serious public health concern by many public health agencies and professional organizations, locally and across the globe.^{1,4,6,40,44} The risks posed by e-cigarettes are many, particularly to adolescents, who have skyrocketing rates of nicotine addiction, vulnerability to lung injury, potential impairment of cognitive function, and increased risk of traditional combustible cigarette use. Vaping of marijuana and THC has also increased exponentially, putting adolescents who use at risk for adverse impact on developing neurological function. Proliferation of novel, innovative devices, vaping methods, and flavoring which are effectively marketed to adolescents, has been associated with the exponential increase in vaping rates in this population. Although e-cigarettes have less toxicants and carcinogens than traditional cigarettes, there is still exposure to these substances and nicotine exposure is significant. Development of effective strategies to prevent use of these products for non-smokers is essential to address what the US Surgeon General refers to as an epidemic.

Health care professionals, scientists, and policy makers need to consider the influence of the tobacco industry on the data used to decide policy. Support of independent research and transparent policy and regulation development is essential, especially as the devices, the vaping liquids, the ingredients evolve, affecting public health.

Use of combustible tobacco is responsible for tremendous disease, disability, and death. Promoting and supporting smoking cessation is an essential aspect of any treatment strategy for preventing the development of and worsening disease. Effective strategies for harm reduction may include the use of e-cigarettes in certain circumstances.

Evidence is mounting about the efficacy of e-cigarettes as a smoking cessation tool for those non-pregnant adults who have failed traditional, approved strategies, such as NRT (gum and patches), behavioral support, and medications (varenicline). However, the evidence on relapse to smoking and continued

dual use of e-cigarettes are serious concerns as is the risk of nonsmokers who use of e-cigarettes may increase their risk of starting traditional combustible cigarettes. These public health concerns are worrisome, need to be monitored and shared with anyone considering using these devices as smoking cessation aids. Guidance supports short term use of e-cigarettes as an approach to stop smoking and nicotine use. It is essential for health care professionals to engage in shared decision making with their patients who smoke, which should incorporate a thorough discussion of known harms and recognition that there are likely harms, still unknown to us. Strategies to prevent use of these devices by nonsmokers are equally as important to public health as potential limited efficacy of harm reduction.

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