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Study finds electronic tobacco devices emit more tar than regular cigarettes

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IQOS and Lil cigarettes found as key perpetrators

Models of the IQOS, an electronic heat-not-burn tobacco device, are displayed at convenience store in Seoul's Mapo district. (Lee Jeong-a, staff photographer)

A South Korean government study has found that some heat-not-burn tobacco devices that are being sold in South Korea contain more tar, a harmful substance, than ordinary cigarettes. On June 7, South Korea's Ministry of Food and Drug Safety (MFDS) released the findings of an analysis of 11 harmful ingredients, including nicotine and tar, in the smokeless cigarettes released by three companies: IQOS by Philip Morris Korea, Glo by British American Tobacco and Lil by KT&G. In a three-day analysis consisting of three tests per day (in line with the standards of the International Organization for Standardization), the Testing Analysis and Assessment Committee, which is composed of experts in tobacco and environmental analysis, found that IQOS and Lil cigarettes emitted an average of 9.3mg and 9.1mg of tar, respectively. That was higher than the tar content (4.3–5.8mg) of

the five kinds of ordinary cigarettes most commonly sold in the country. “There are no grounds for arguing that heat-not-burn tobacco devices are less harmful than ordinary cigarettes. However, ordinary cigarettes and heat-not-burn tobacco devices may include different kinds of tar, which limits the utility of comparing harmfulness based on the detected amount,” the MFDS said, based on its analytical findings. These three products had a similar average nicotine content to ordinary cigarettes. When analysts scanned for nine substances other than nicotine and tar that the World Health Organization advises people to reduce their intake of, including Group 1 carcinogens, eight of those substances (all except for 1,3-Butadiene) were detected. On average, the content of these eight substances was lower than in regular cigarettes. Philip Morris Korea argued that the MFDS’s analytical findings “demonstrate once again our basic research findings that these products contain fewer harmful materials [than regular cigarettes].” By Park Hyun-jung, staff reporter Please direct comments or questions to [english@hani.co.kr] Original Korean

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June 7, 2018

A government official speaks about the analysis of the level of 11 toxicants in heat-not-burn cigarettes available in Korea during a media briefing at the Ministry of Food and Drug Safety, Thursday. Yonhap

By Lee Kyung-min

Three heat-not-burn (HNB) cigarettes available in Korea contain five Group 1 carcinogens classified by the International Agency for Research on Cancer (IARC), with similar-to-higher levels of two other harmful substances compared to conventional cigarettes, a government study showed Thursday.

A study commissioned by the Ministry of Food and Drug Safety analyzed the level of 11 toxicants in Philip Morris International Korea's IQOS, domestically produced lil by KT&G, and British American Tobacco Korea's glo. They include nicotine, tar as well as nine toxicants, six of which are Group 1 carcinogens the World Health Organization (WHO) recommends for mandated lowering.

A method approved by the International Organization for Standardization (IOS) showed glo, lil and IQOS, contained 1mg, 3mg and 5mg, of nicotine respectively, within similar range of 100 top-selling cigarettes on the market between 0.01 mg and 0.7 mg. However, lil and

IQOS contained 9.1 mg and 9.3 mg of tar, respectively, above 8 mg, the highest level found in an average of 100 such cigarettes.

The three products contained five out of the six Group 1 carcinogens, except 1,3-Butadiene. The remaining toxicants are NNK, NNN, benzene, benzoapyrene and formaldehyde. The Group 2B carcinogen acetaldehyde was found alongside acrolein and carbon monoxide. Over six times more toxic substances were found through a different method approved by Health Canada, in a more stringent test, premised on the greater smoke intake depending on the individual smoker's ㅏ pattern of inhalation.

The study could slow the sales of and dispel the common misconceptions about HNB products. Manufacturers of HNB products have claimed the smoke produced after heating and not burning contains fewer harmful substances and therefore poses less of a threat to health, the main reason many smokers switched from cigarettes to the seemingly "healthier" HNBs which led to brisk sales since their launch in May last year.

According to the WHO, however, all forms of tobacco use are harmful, including HNBs. "Tobacco is inherently toxic and contains carcinogens even in its natural form, and therefore they should be subject to policy and regulatory measures applied to all other tobacco products, in line with the WHO Framework Convention on Tobacco Control." Korea is bound by the treaty to fight the tobacco epidemic.

The study comes amid increasing popularity of HNB products only a year after their launch in Korea. Data from the Ministry of Strategy and Finance showed that over 28 million HNB packs were sold as of April, a near 14-fold increase from only about 200,000 packs sold in May last year. HNBs account for 9.4 percent of the market.

Meanwhile, the government is continuing its efforts to curb smoking. The Ministry of Health and Welfare unveiled a set of smoking deterrence measures last month to replace the current graphic warnings with more "disturbing" ones similar to warnings all other cigarette manufacturers currently use. The measure seeks to provide facts, intending to increase their effectiveness in preventing nicotine consumption including HNB products. New warnings must completely replace the current warnings by Dec. 23, six months after the official announcement of the plan between May 14 and June 4.

Five carcinogens found in "heat-not-burn" e-cigarettes

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궐련형 전자담배에 1급 발암물질 5종...타르 일반담배보다 많아 There's been widespread belief the so-called "heat-not-burn" electronic cigarettes are safer than conventional ones... as they heat tobacco to a temperature high enough to create vapor not smoke. But that may not be true, as health authorities in the nation announced there's no reason to believe these relatively new devices are less toxic. Our Ko Roon-hee explains further. It's been a little over a year since so-called "heat-not-burn" electronic cigarettes came onto the Korean market, and they've caught on quickly among smokers. According to the Ministry of Strategy and Finance, as of this April, heat-not-burn products had a cigarette market share of almost 10 percent. However, the Ministry of Food and Drug Safety released analysis Thursday... saying there is no evidence that these products are less harmful than conventional cigarettes. Together with outside researchers, the ministry studied three popular e-cigarette products -- the Lil by local tobacco company KT&G, the Glo by British American Tobacco, and the iQOS by Philip Morris. In them, it found five substances classified as five substances classified as "first level carcinogens" by the International Agency for Cancer. However, the amounts were only between zero-point-3 percent and 28 percent of those found in conventional smokes. The amount of nicotine was similar to that found in ordinary cigarettes -- between a tenth and one half of a milligram. The ministry added that two of the products, though, contained more tar. "Some of the heat-not-burn electronic cigarettes contain more tar than regular ones. This means these e-cigarettes could contain other toxic substances...not found in regular tobacco." But the report was met with a backlash from manufacturers, who've called it meaningless. They say it's not appropriate to simply compare amounts of tar... because tar is produced when tobacco is burned, which their devices don't do. This isn't the first warning from the government about heat-not-burn cigarettes. The health ministry announced last month that twelve new written and graphic warnings will be put on heat-not-burn cigarettes starting this December. The government is also working on a law to make manufacturers submit a full list of the ingredients and toxic substances in the heat-not-burn cigarettes and disclose the information to the public. Ko Roon-hee, Arirang News.

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The Korea Herald

Retail & Consumer

Korea vs. HNB cigarette makers

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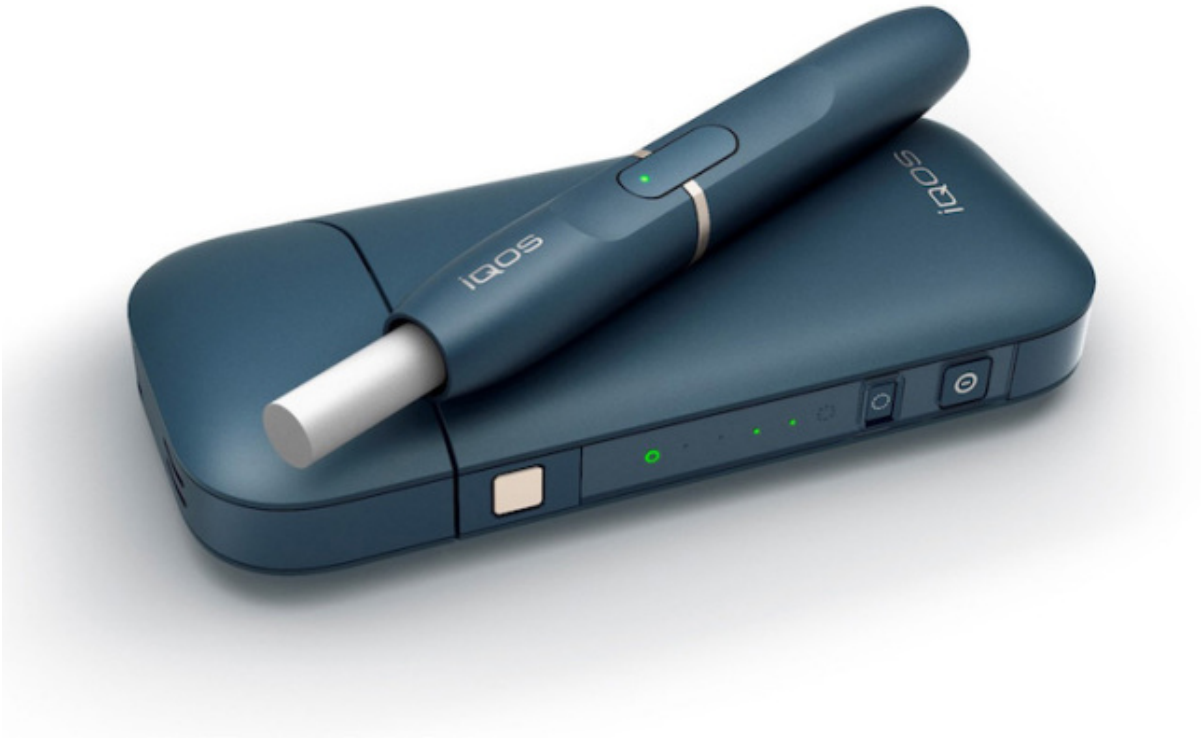
[THE INVESTOR] The Korean government has ruled that heat-not-burn cigarettes are not less harmful than conventional cigarettes. The findings appear to run counter to what the tobacco makers say.

On June 7, the Ministry of Food and Drug Safety said that HNB cigarettes contain less toxicants compared to conventional cigarettes, but that they can still cause serious diseases including cancer, and therefore it is hard to say that they are less harmful.



PMI's IQOS.

In particular, it said that two of the brands -- Philip Morris International's IQOS and KT&G.'s Lil -- release more tar than conventional cigarettes. The data showed that IQOS and Lil release 9.3 mg and 9.1 mg of tar on average,respectively, which is higher than the 0.1-8.0 mg of traditional cigarettes. British American Tobacco's Glo releases 4.8 mg of tar on average, the ministry said.

It also said that while it's impossible to compare the two types of cigarettes due to their limited sources, this also means considering that cigarettes contain more than 7,000 kinds of hazardous chemicals, HNB cigarettes may be even more harmful than meets the eye.

As of April this year, 9.4 percent of Korean smokers switched to HNB cigarettes, according to the ministry's data. Philip Morris Korea is the biggest player with up to a 60 percent market share, followed by KT&G and BAT. Below are the response from the three HNB cigarette makers and some consumers.

Phillip Morris Korea: The ministry's results are misleading. First of all, tar is a term that indicates all elements, excluding water and nicotine, that are released when burning tobacco. So it is not a synonym for "harmful component." It also can't be used as a measure for HNB cigarettes since they aren't burned to be smoked. Moreover, the quality of vapor released by HNB cigarettes and conventional cigarettes are completely different, so it's impossible to compare.

BAT Korea: Tar is not synonymous with "harmful element." It's just a term used for all the combined components produced when burning conventional cigarettes. Just because it has more tar, it does not mean it is more harmful. The ministry should have indicated specifically what elements in HNB cigarettes vapor are more harmful. Furthermore, when comparing the nine harmful elements designated by the WHO, the ministry's findings show that HNB cigarettes contain less toxicants.

KT&G: We will have to look into the ministry findings more closely. We are however, also concerned about the definition of tar, and how it should be interpreted in HNB cigarettes.

HNB cigarette smokers:

Kim Gi-woong, a Lil user says, “I switched to HNBs thinking they would be less harmful. But now it seems like the cigarette makers duped us. I don’t know what to trust.”

Lee Joo-ho, an IQOS user says, “I got more confused. The government says that it is as harmful as traditional cigarette while also saying that it contains less amount of toxicants.”

Song Eun-suk, also an IQOS user says, “Since it’s hard to figure what to trust, I guess I will just continue to smoke IQOS just because they smell less.”

By Song Seung-hyun (ssh@heraldcorp.com)

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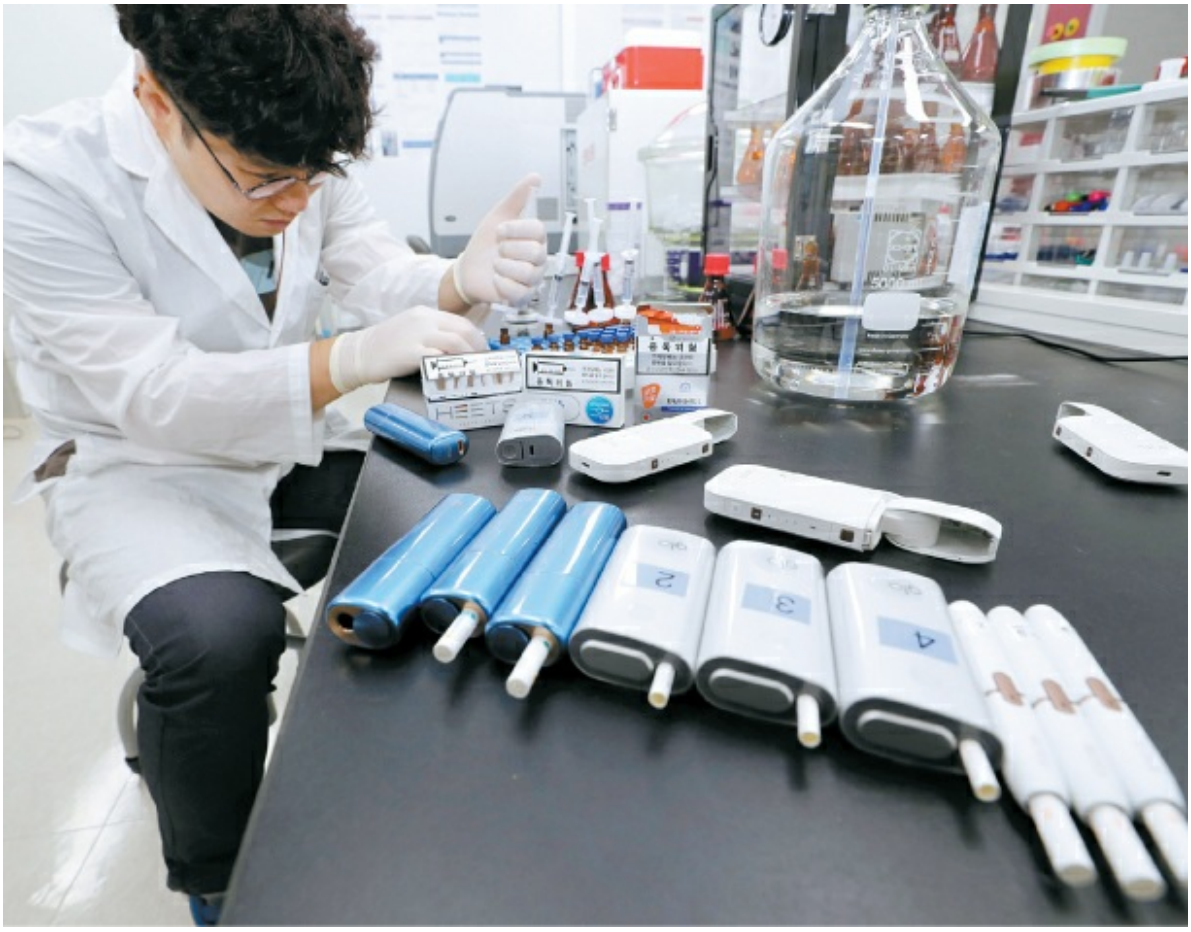

이미지뷰

A researcher at the Ministry of Food and Drug Safety demonstrates the analysis of substances produced from heat-not-burn cigarettes at a lab in Cheongju, North Chungcheong, on Thursday. [YONHAP]

Heat-not-burn cigarettes are no safer than ordinary cigarettes, according to government test results, and produce harmful substances related to cancer - and possibly even more tar.
Tobacco makers disagreed and claimed the results will only confuse smokers.

On Thursday, the Ministry of Food and Drug Safety announced the results of an 11-month investigation of the safety of heat-not-burn cigarettes.

There are currently three heat-not-burn cigarettes being sold in Korea: Philip Morris Korea's IQOS, British American Tobacco's glo and KT&G's lil. While ordinary cigarettes burn tobacco leaves to make smoke, heat-not-burn cigarettes produce vapor by steadily heating the leaves at a lower temperature.

Manufacturers have promoted the product as a less harmful alternative to conventional cigarettes, a claim the government refuted on Thursday.

The smoke produced from the three brands of heat-not-burn cigarettes was analyzed to measure nicotine, tar and nine harmful substances the World Health Organization has criticized in cigarettes.

Tar collectively refers to substances produced during combustion, except for water and nicotine. The government test results showed that the three heat-not-burn products produced levels of tar between 4.8 and 9.3 milligrams. IQOS and lil produced more tar than some of the most popular ordinary cigarettes, which normally produce less than 8 milligrams.

The nicotine content of the heat-not-burn cigarettes was between 0.1 and 0.5 milligrams. Ordinary cigarettes produce between 0.01 and 0.7 milligrams.

Regarding the nine other harmful substances, heat-not-burn cigarettes produced levels between zero to 30 percent of the amount produced by ordinary cigarettes.

"Two heat-not-burn cigarettes produced more tar than conventional cigarettes," said a government statement, adding that they may contain harmful substances not found in conventional cigarettes.

It also said that heat-not-burn cigarettes can't be used to help quit smoking if they produce similar levels of nicotine, an addictive substance, and that heat-not-burn cigarettes can cause diseases like cancer.

"We plan to effectively use the test results to supervise cigarette products and establish antismoking policies," the government said in its statement.

Heat-not-burn manufacturers rebutted the claims, sticking to the stance that the products are much safer than ordinary cigarettes. Their main point was that it is wrong to deem heat-not-burn cigarettes as dangerous based on the total amount of tar.

"Tar itself is not a harmful substance; it's a term referring to all substances in the cigarette smoke aside from nicotine and water," Philip Morris Korea said in a statement.

"Vapor from heat-not-burn cigarettes and smoke from combustible cigarettes are fundamentally different," it continued. "Therefore the comparison should be based not simply on the total amount of tar, but specifically the content of harmful substances."

Philip Morris Korea and British American Tobacco Korea (BAT) both said that in terms of harmful substances, the government's report aligns with their research as the nine substances defined as harmful by the WHO had all been detected in much smaller amounts than ordinary cigarettes.

“We can’t define all of the substances [that constitute vapor or smoke], which is why the WHO designated certain substances [to regulate] that are the most harmful,” said a BAT Korea spokesman. “They are harmful substances defined by credible global institutes and that’s what we should judge health effects upon.”

Regarding the government’s criticism of nicotine content, both companies said that they never said heat-not-burn cigarettes were nicotine-free.

BY SONG KYOUNG-SON [song.kyoungson@joongang.co.kr]

Electronic cigarette use in youths: a position statement of the Forum of International Respiratory Societies

Abstract

Children and adolescents are highly susceptible to nicotine addiction, which affects their brain development, even in those who smoke infrequently. Young people who become addicted to nicotine are at greater risk of becoming lifelong tobacco consumers. The use of nicotine-delivering electronic cigarettes has risen dramatically among youths worldwide. In addition to physical dependence, adolescents are susceptible to social and environmental influences to use electronic cigarettes. The product design, flavours, marketing, and perception of safety and acceptability have increased the appeal of electronic cigarettes to young people, thus leading to new generations addicted to nicotine. Moreover, there is growing evidence that electronic cigarettes in children and adolescents serve as a gateway to cigarette smoking. There can be no argument for harm reduction in children. To protect this vulnerable population from electronic cigarettes and other nicotine delivery devices, we recommend that electronic cigarettes be regulated as tobacco products and included in smoke-free policies. Sale of electronic cigarettes should be barred to youths worldwide. Flavouring should be prohibited in electronic cigarettes, and advertising accessible by youths and young adults be banned. Finally, we recommend greater research on the health effects of electronic cigarettes and surveillance of use across different countries.

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It is the position of @lungsfirst that nicotine in electronic cigarettes poses a great threat to youth and we must protect them from it http://ow.ly/DfWJ30jIes7

Introduction

Smoking is not safe at any age, but prevention in children and adolescents has long been a public health priority. Tobacco dependence starts in childhood; close to 90% of current cigarette smokers start before their 18th birthday. The tobacco industry understands that youths, often referred as “replacement smokers” or “learners” in industry documents, are their critical market [1, 2]. Advertising campaigns have notoriously targeted youths [3–5]. Despite these pressures, teen smoking prevention strategies have generally been successful. For instance, combustible cigarette smoking among middle and high school students in the USA has fallen over the past few decades [6]. Although smoking remains high in some regions of Europe, the Health Behaviour in School-aged Children study showed that weekly tobacco smoking declined among adolescents in almost all countries between 2009 and 2014 [7].

However, a new threat to the health of children and adolescents has emerged,*i.e.*

electronic cigarettes or electronic nicotine delivery systems (ENDS), although these devices need not be in the form of a cigarette nor deliver nicotine [8]. They have many other names, including vapes, vape pens, e-hookahs, electronic shishas, mechanical mods, Juul and others, but for the purposes of this position statement, we will use the term electronic cigarettes. Another related method of delivering nicotine, *i.e.* heat-not-burn devices [9], is not discussed here.

Electronic cigarettes deliver aerosols of nicotine and other chemicals to the lung. Although there are no universal or mandatory regulations or standards on content, these devices contain a vehicle (usually propylene glycol and glycerine), flavouring agents and nicotine. Other toxicants can be present as contaminants or generated by heating the solution, and other substances, such as marijuana and cannabis derivatives, can be added to the solution [10, 11]. Additionally, the aerosol exhaled by the user can involuntarily expose bystanders. Most electronic cigarettes release nicotine and other potentially toxic and irritating substances into the air [12].

Following repeated exposure to nicotine, the human central nervous system undergoes structural and functional adaptations, such that the brain requires nicotine to function normally, resulting in complex, biosocial maladaptive behaviours, known as dependence [13, 14]. Given their developmental stage, adolescents and young adults are uniquely susceptible to social and environmental influences to use tobacco [8, 15–17] and nicotine addiction [18, 19]. Several lines of evidence indicate that nicotine exposure during adolescence may have lasting adverse consequences for brain development [3, 20–22], even in those who smoke infrequently. Signs of nicotine dependence can appear within days to weeks of starting occasional use, often before the onset of daily smoking [23]. Data have shown that monthly smoking greatly increases the likelihood of developing dependence in youths [24, 25]. These findings in humans are supported by many animal studies that have provided mechanisms by which nicotine can lead to a pathway of addiction [26].

In 2014, the Forum of International Respiratory Societies, a collaborative of nine international professional organisations that was created to promote respiratory health worldwide, published a position statement concerning electronic cigarettes that outlined existing scientific data and advised caution until more information about their safety and effect on society are known [27]. During the 4 years since its publication, much has been learned about the claimed health benefits and risks of electronic cigarette use, particularly in adolescents and young adults. The current position statement addresses these issues.

Electronic cigarettes and nicotine addiction

With the public's appreciation of the serious health consequences of smoking [28], manufacturers modified tobacco products and marketed them with claims of fewer “toxins” and “carcinogens”. These products, such as filtered, “low tar” and “light” cigarettes, have not resulted in less harm [3, 13, 29–31]. Because they are perceived to have lower health risks, electronic cigarettes are the latest addition to the list of industry products implying a beneficial safety profile. Electronic cigarette promoters, users and some professionals judge these electronic nicotine delivery devices to be safer than cigarettes [32–34], despite

a lack of strong empirical evidence to support this claim. These judgements miss the point that comparing anything to a product that kills 7 million people each year should have a favourable conclusion and disregard the current trend of decreasing smoking rates without electronic cigarette use.

As noted previously, various nicotine delivery devices are available, with an array of design features and constituent components that significantly influence their pharmacological and toxicological profiles [35]. Evidence is emerging suggesting compensatory behaviours occur in response to this variation, in a manner similar to that identified in cigarettes several decades ago [36]. Electronic cigarettes are as capable of saturating brain nicotinic receptors as conventional cigarettes [37]. This effect may not concur with the nicotine content listed on refill bottles, which may reflect inaccuracy of labelling and manufacturing. Although some studies have shown that nicotine content corresponded to product labelling, analyses of the ingredients of different flavoured, nicotine and no-nicotine cartridges showed that quality control processes used to manufacture these products can be inconsistent [38]. Some products labelled “nicotine-free” contained nicotine [38]. Electronic cigarettes with higher nicotine concentrations increased subsequent frequency and intensity of conventional smoking and vaping [39]. Also, although self-reported data suggest that 80% of adolescents choose products that do not contain nicotine [40], 99% of electronic cigarettes sold in US convenience stores, supermarkets, drug stores and through mass merchandisers contain nicotine [41].

Pulmonary toxicity of electronic cigarettes

Although the National Academies of Sciences, Engineering and Medicine found substantial evidence that exposure of potentially harmful ingredients from electronic cigarettes is significantly lower than combustible cigarettes [12], it does not mean that electronic cigarette aerosols are “harmless vapour” as industry has claimed in the past [8]. The vapour contains ultrafine particulates, volatile organic compounds and heavy metals, such as nickel, tin and lead [38, 42–44]. The ultrafine particle concentration, size distribution of the particles and deposition pattern in the lungs is similar for electronic cigarette vapour and conventional cigarettes [45, 46]. Electronic cigarettes often come with added flavourants. A flavouring that has been determined to be safe to eat may be toxic when inhaled. These substances are not inert and have been shown to injure airway epithelial cells *in vitro* [47]. Exposure to aerosol extracts causes significant DNA damage in human oral and lung cells, highlighting the need to further investigate the long-term cancer risk of exposure to these products [48]. Inhalation of electronic cigarette aerosols leads to pulmonary inflammation, impaired innate immunity, reduced lung function and changes consistent with chronic obstructive lung disease (emphysema) in pre-clinical animal models [49–52]. Studies in humans, including adolescents, in the USA, South Korea and China have linked their use to chronic or recurrent respiratory symptoms [53–56]. More recently, proteomic analyses of bronchoalveolar lavage collected from nonsmokers, smokers and vapers clearly showed that electronic cigarette vapours exert marked and extensive biological effects on human airways, albeit different than tobacco smoke. These findings suggest that inhalation of vapour is not innocuous and raises concern that electronic cigarettes “should not be prescribed as a safe or harmless tobacco alternative” [57]. Thus, regardless of the presence or absence of nicotine, exposure to electronic cigarette aerosol

in adolescence and early adulthood is not risk-free and can result in pulmonary toxicity.

Electronic cigarette use among children and adolescents

Over the past decade, electronic cigarettes have risen rapidly in popularity among young people in many countries [58]. Based on data collected for the US National Youth Tobacco Survey, over 1.6 million high school students and 500 000 middle school students used electronic cigarettes in 2015, 10 times the number of reported users 4 years earlier [59]. An extensive survey of eighth- and ninth-grade students in the state of Oregon found that they were the most common introductory tobacco product used [60]. The product design, flavours, marketing, and perception of safety and acceptability increase the appeal of these products to young people [61]. Electronic cigarette advertisements on internet sites, retail stores, movies and other media are associated with growing use among students. Greater exposure has been associated with higher odds of use [62]. Much of the marketing is through the internet and social networking sites, with posted personal videos displaying the use of the product.

Data on awareness and electronic cigarette use among 35 000 surveyed youths from 25 countries reported overall that their awareness ranged from 15% in Kazakhstan to 80% in Italy and that the past 30-day use ranged from 0.8% in Guyana to 15% among 15-year-old Danish boys and girls [63]. The International Tobacco Control Four-Country Survey, which included data from the USA, Canada, the UK and Australia, found the prevalence of trying electronic cigarettes was higher in young, nondaily smokers because of the perception that they were safer compared with traditional combustible cigarettes [62].

Another common reason for using electronic cigarettes among both youths and young adults is flavouring or taste. Even though flavourings are limited or banned in conventional combustible cigarettes by some countries, they are widely permitted in electronic cigarettes in all nations [64]. These restrictions reflect the well-known use of flavourings to promote tobacco product initiation among adolescents. The lack of regulation creates a fertile environment for the expansion of flavoured electronic cigarette marketing to the young [65]. In 2014, more than 7500 distinct, flavoured electronic cigarette products and solutions were available on the internet with over 250 new products introduced per month [66]. Data from the Population Assessment of Tobacco and Health Study and the National Tobacco Youth Survey revealed that 63–70% of youth users of tobacco products choose flavoured products [67, 68]. Furthermore, data from the National Tobacco Youth Survey showed that flavoured electronic cigarette use was associated with increased risk of smoking combustible cigarettes, supporting a plausible gateway effect [69].

Child and adolescent use of tobacco products reflects experimentation and initiation behaviours that ultimately lead to nicotine addiction. In a large cohort, 81% of youth users of electronic cigarettes reported that their starter product was flavoured compared with 61% and 46% of young and all adults, respectively [67]. Electronic cigarette manufacturers employ diverse and creative strategies to target marketing to adolescents and teens despite widespread bans on the sale of these products to persons less than 18 years of age. Advertising near middle and high schools, in neighbourhoods with high youth traffic, and on television commercials that appeal to youths are common approaches [70–72].

Packaging and display choices, such as candy and fruit iconography on the packaging, displays close to candy, and marketing materials at or below 3 feet (1 m) all enhance interest by youths [73]. For older adolescents and young adults, claimed safety benefits with flavoured electronic cigarettes have encouraged experimentation.

In the USA, electronic cigarette use among students has increased dramatically, and past-30-day use of electronic cigarettes among eighth-,10th- and 12th-grade students exceeded use of conventional cigarettes in 2015 [74, 75]. Among US middle and high school students, both ever and past-30-day electronic cigarette use has more than tripled since 2011. This phenomenon is not restricted to US youth. Although data is lacking for many countries, several national reports have shown marked increases in electronic cigarette use in children and adolescents. Based on survey data, 10–12% of high school students from the UK and South Korea have used electronic cigarettes [76, 77]. According to the National Health Institute survey conducted in Italy, 14% of consumers were adolescents and young adults. Moreover, 24% of Italian adolescent and young adult smokers preferred electronic cigarettes to combustible cigarettes [78, 79]. A large sample of Polish students showed that 24% had tried an electronic cigarette and 7% used them within 30 days of the survey [80]. Similar data have been reported in older Irish teens, with nearly 70% of combustible smokers also using electronic cigarettes [81]. Among students in Finland, aged 12–18 years, 17% had tried electronic cigarettes [82].

Adolescents who use electronic cigarettes tend to be more likely those at higher risk of initiating cigarette smoking [83, 84]. As nicotine addiction develops, the barriers to the use of other tobacco products decrease. Multiple tobacco product use is common among youths.

Nonetheless, there is “substantial” evidence that vaping increases the risk of combustible cigarette use in children and adolescents [85]. While some publications from Great Britain have downplayed the use of electronic cigarettes and their link to combustible cigarette use in adolescents [86, 87], numerous longitudinal studies have confirmed their role as a gateway to more conventional tobacco products [88–91]. A recent large survey of demographically diverse adolescents from 20 schools across England showed that ever-use of electronic cigarettes was strongly associated with smoking initiation and escalation [92]. Meta-analysis of seven studies that included over 8000 adolescents and young adults who were not cigarette smokers at baseline found that among those who had ever used electronic cigarettes, the probability of combustible cigarette smoking initiation was nearly four-fold greater than nonusers [88]. A longitudinal study of US high school students in Connecticut found that electronic cigarette use was associated with subsequent initiation of combustible cigarette use, whereas combustible cigarette use was not associated with subsequent electronic cigarette use. Furthermore, they found that frequency of both electronic cigarette and combustible cigarette use increased over time, consistent with the development of nicotine addiction [93]. The COMPASS study showed that recent electronic cigarette use among Canadian secondary school students was strongly associated with cigarette smoking status and susceptibility to future use [90]. An internet-based survey of young adults in California, aged 18–24 years, found that increased levels of electronic cigarettes use were associated with increased combustible cigarette use: those who used electronic cigarettes regularly smoked combustible cigarettes more heavily than occasional

electronic cigarette users [94]. The association between electronic cigarette use and initiation of combustible cigarette smoking was much stronger among adolescents classified as not susceptible to becoming smokers [8]. These data indicate that electronic cigarette use in adolescents does not decrease the likelihood of combustible cigarette use. Rather, “vaping” is associated with increased combustible cigarette smoking among youths.

Youth marketing of electronic cigarettes

Electronic cigarettes are frequently marketed using tactics and themes that have previously been shown to influence use of conventional tobacco products among youths. Exposure of US middle and high school students to electronic cigarette advertising from any source increased between 2014 and 2016, with greatest exposure in retail stores, followed by the internet, television, and newspapers and magazines [95]. However, in contrast to conventional tobacco products, few studies have examined the effectiveness of electronic cigarette advertising and promotions on children and adolescents. A study of 600 British children, aged 11–16 years, showed that electronic cigarette advertising increased the appeal of electronic cigarettes and interest in trying them [96]. In the National Tobacco Youth Survey, exposure to advertising was associated with current cigarette use among US middle and high school students [62, 97]. Of the 80% of adolescents who were exposed to electronic cigarette advertising in the Youth Tobacco Policy Survey, the great majority said flavourings were a prominent selling feature and that electronic cigarettes were associated with less perceived harm [98]. Indeed, flavourings and harm reduction are common selling points for electronic cigarettes for both internet electronic vendors and retail stores staff [99]. The 2014 US Surgeon General Report concluded that advertising and promotional activities by the tobacco companies cause the onset and continuation of smoking among adolescents and young adults [3], and evidence to date suggests they have the same impact on electronic cigarette use by youths. For this reason, advertising and promotion of electronic cigarettes in media that can be accessed by youths should be banned, and these activities for electronic cigarette manufacturers must be closely monitored.

Regulation of electronic cigarettes

Electronic cigarettes are variably regulated around the world [100]. In 25 countries, their sale is banned. In other nations, they are regulated as tobacco-related products, medicines, poisons, electrical appliances or consumer goods. Even in Europe, electronic cigarette regulation varies widely. Some countries apply many regulatory domains whereas others apply few. For instance, Portugal has regulations on child safety, advertising, promotion, sponsorship, health warning labelling, ingredients, flavours, minimum age, nicotine volumes and concentrations, reporting, safety, sale, tax, and vape-free areas. In contrast, Switzerland has no regulation but prohibits sale of nicotine-containing devices. Norway recently lifted its ban on electronic cigarettes, but Belgium, Austria and Turkey prohibit the sale of all products.

In 2016, only 23 countries had implemented minimum age-of-purchase policies [100], although a law on a minimum age-of-purchase has little or no effect if it is not enforced. Minors are easily able to purchase electronic cigarettes from the internet because of absent

or weak age verification measures used by vendors. A recent study showed that minors successfully received deliveries of electronic cigarettes from 77% of purchase attempts and delivery companies never attempted to verify their age at delivery [101].

Data from six European countries indicated that electronic cigarette sales fall with price increases [102]. Another large study from European countries, which included adolescents and young adults, found that the prevalence of electronic cigarette use was proportionate to current conventional cigarette smoking. Large pictorial health warnings on tobacco products were negatively associated with current electronic cigarette use [103].

Strong regulation can protect youths from electronic cigarettes. In 2008, Korea regulated electronic cigarettes as tobacco products with prohibitions on indoor use, sales to minors, advertising bans, health warnings and taxes. While various municipalities have restricted the sale of electronic cigarettes to adolescents and young adults, there had been little federal regulation in the USA. From 2011 to 2015 the prevalence of the use of electronic cigarettes remained stable at about 4% in Korea, whereas it rose dramatically from 1% to 11% in the USA during the same period [104].

In 2016 there was a decline in electronic cigarette use in US middle school and high school students [74], temporally associated with the Food and Drug Administration enacting the “deeming rule” that broadened the definition of “tobacco products” to include electronic cigarettes, and made them subject to regulations set by the Family Smoking Prevention and Tobacco Control Act [65]. Concurrently, use of combustible cigarettes did not significantly change, which contradicts the hypothesis that use of electronic cigarettes protects adolescents from initiation of regular smoking. Increasing awareness of possible negative health effects of electronic cigarette use and control strategies at the national and state levels may have contributed to the reduction in electronic cigarette use in the USA [65]. However, a longer trend is needed to make firm conclusions, and continued vigilance is needed to further reduce electronic and combustible cigarette use among youths.

Conclusion and recommendations

ENDS are devices that deliver aerosols of nicotine and other volatile chemicals to the lung. Their use has rapidly escalated among youths and they are now the most commonly used tobacco product among adolescents. Initiation of electronic cigarette use is strongly associated with the subsequent initiation of combustible tobacco product use among adolescents. Electronic aerosols contain potentially harmful ingredients that often lead to lung injury and chronic respiratory symptoms in users. Hundreds of electronic cigarette brands with thousands of unique flavours are now on the market and some flavourings have been associated with lung toxicity. Indeed, flavourings increase the appeal to youths. Even though it is widely accepted that electronic cigarettes are harmful to youths and lead to nicotine addiction, their regulation varies widely between countries. Existing laws designed to prevent youth access of electronic cigarettes are frequently not enforced.

Based on this information, the Forum of International Respiratory Societies recommends:

1. To protect youths, ENDS should be considered tobacco products and regulated as such, including taxation of electronic cigarettes and supplies. The addictive power of nicotine and its adverse effects in youths should not be underestimated.
2. Considering the susceptibility of the developing brain to nicotine addiction, the sale of electronic cigarettes to adolescents and young adults must be prohibited by all nations, and those bans must be enforced.
3. All forms of promotion must be regulated and advertising of electronic cigarettes in media that are accessible to youths should cease.
4. Because flavourings increase rates of youth initiation, they should be banned in electronic nicotine delivery products.
5. As electronic cigarette vapour exposes nonusers to nicotine and other harmful chemicals, use should be prohibited in indoor locations, public parks, and places where children and youths are present.
6. While their health risks are increasingly recognised, more research is needed to understand the physiological and deleterious effects of electronic cigarettes.
7. Routine surveillance and surveys concerning combustible and electronic cigarette use should be carried out in many settings to better understand the scope and health threat of tobacco products to youths in different countries and regions.

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View Abstract

E-cigarette vapour enhances pneumococcal adherence to airway epithelial cells

Lisa Miyashita, Reetika Suri, Emma Dearing, Ian Mudway, Rosamund E Dove, Daniel R. Neill, Richard Van Zyl-Smit, Aras Kadioglu, Jonathan Grigg

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Abstract

E-cigarette vapour contains free radicals with the potential to induce oxidative stress. Since oxidative stress in airway cells increases platelet-activating factor receptor (PAFR) expression, and PAFR is co-opted by pneumococci to adhere to host cells, we hypothesised that E-cigarette vapour increases pneumococcal adhesion to airway cells.

Nasal epithelial PAFR was assessed in non-vaping controls, and in adults before and after 5 min of vaping. We determined the effect of vapour on oxidative stress-induced, PAFR-dependent pneumococcal adhesion to airway epithelial cells *in vitro*, and on pneumococcal colonisation in the mouse nasopharynx. Elemental analysis of vapour was done by mass spectrometry, and oxidative potential of vapour assessed by antioxidant depletion *in vitro*.

There was no difference in baseline nasal epithelial PAFR expression between vapers (n=11) and controls (n=6). Vaping increased nasal PAFR expression. Nicotine-containing and nicotine-free E-cigarette vapour increased pneumococcal adhesion to airway cells *in vitro*. Vapour-stimulated adhesion *in vitro* was attenuated by the PAFR blocker CV3988. Nicotine-containing E-cigarette vapour increased mouse nasal PAFR expression, and nasopharyngeal pneumococcal colonisation. Vapour contained redox-active metals, had considerable oxidative activity, and adhesion was attenuated by the antioxidant N-acetyl cysteine.

This study suggests that E-cigarette vapour has the potential to increase susceptibility to pneumococcal infection.

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Exposure of airway cells to E-cigarette vapour upregulates a receptor used by pneumococci to adhere to cells http://ow.ly/p9Be30hE5B1

Footnotes

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Back to top

Electronic cigarette: Friend or foe?

Radwa Elhefny, Mohamed Amin, Assem Elessawy, Esam Esam Gad El-Rab

European Respiratory Journal 2016 48: PA2024; DOI: 10.1183/13993003.congress-2016.PA2024

- Article
- Info & Metrics

Abstract

Background: Electronic cigarettes (ECs) have been developed and marketed in recent years as smoking substitutes. Using e-cigarettes is called "*vaping*". However, no comprehensive studies have evaluated their effects on the respiratory system. Objective:The purpose of this study is to evaluate the immediate effect of ECs vapors on airway mechanics.

Methods: 40 apparently healthy never or light smoker individuals divided into 2 groups. The first group was instructed to "*vape*" an EC with 12 mg nicotine filled cartridge and the second group was asked to vape an EC with empty cartridge. Pulmonary function tests were assessed pre and post *"vaping"*.Results:a significant increase in peripheral airway resistance of the first group which vape nicotine filled cartridge.Conclusions:ECs have immediate adverse physiological effects after short-term use, that are similar to documented effects of tobacco smoking.

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Back to top

E-cigarette acute effect on symptoms and airways inflammation: Comparison of a nicotine containing with a non-nicotine device

Sofia Vakali, Stamatoula Tsikrika, Sofianna Antiopi Gennimata, George Kaltsakas, Anastasios Palamidaw, Nikolaos Koulouris, Christina Gratziou

European Respiratory Journal 2013 42: P1055; DOI:

Abstract

Despite the increasing advertising of e-cigarettes as safe smoking tool, there is much debate regarding its safety.

This study was undertaken to assess the effect of a single e-cigarette use on clinical symptoms, vital signs and airway inflammatory markers after inhaling either 0mg or 11mg of nicotine.

We studied 53 subjects (10 men) divided in 2 groups. Group A: 10 never smokers and 24 healthy smokers smoked for 10 min a single e-cigarette containing 11mg of nicotine and Group B: 11 never smokers and 9 healthy smokers smoked an e-cigarette containing 0mg of nicotine. The same brand of e-cig was used in both groups with similar liquid ingredients but with different nicotine concentrations. Vital signs, symptoms, Oxygen Saturation, heart rate and indices of airway inflammation(exhaled CO, exhaled NO, airways temperature) were assessed pre and post smoking.

All subjects reported symptoms immediately after smoking, but the respiratory (sore throat, cough) and the cardiovascular symptoms (palpitations) were reported more often in Group A compared with Group B, whereas dizziness, was more frequently reported from non smokers of Group B. An increase in HR was noted in all subjects of Group A, findings that were not recorded in group B. A decrease in FeNO was detected in smokers (p= 0,028) and in non-smokers (p= 0,047) of Group B, with an increase in airways temperature (p=0.037) in smokers of Group A. An increase in exhaled CO was detected in all subjects.

Increased heart rate and palpitations are related to the use of a nicotine containing e-cig but airways symptoms (sore throat, cough) and inflammatory markers are independent of nicotine use.

We recommend

Back to top

Electronic cigarette in smoking cessation

Mateusz Jankowski, Grzegorz Brożek, Jan Zejda, Agnieszka Jarosińska, Agnieszka Idzik, Paulina Majek

European Respiratory Journal 2017 50: PA1236; DOI: 10.1183/1393003.congress-2017.PA1236

- Article
- Info & Metrics

Abstract

E-cigarettes has been advertised as an aid to reduce or quit smoking. Evidence regarding the relationship between e-smoking in smoking cessation are inconsistent.

Aim: The aim of the study was to evaluate the effectiveness of e-cigarette use as a tool to aid smoking cessation.

Method: A population based survey performed, in a group of 2500 students from two Universities in Katowice, Poland. The self-prepared, validated questionnaire, included questions on cigarette and e-cigarette smoking habits.

Results: The data were obtained from 1906 students (response rate=76.2%; mean age=21.6±2.2yrs), 64% were female (F) and 36% male (M). Traditional cigarette smoked 15.7% of respondents (F:15%; M:17; p=0.2), e-smoking was declared by 3.2% of respondents (F:2.3%; M:4.8%; p=0.003). Only 33.3% of e-smokers used e-cigarettes as an aid to quit smoking. Since starting e-smoking, a reduction in cigarette consumption (mean 6.7±5.2 cig/daily) was observed by 51.3% of dual smokers. Among e-smokers, 39.2% reported an addiction to e-cigarettes, and 28.6% tried to give up e-smoking. Almost half of e-smokers (48%) used e-liquid with nicotine content less than 8 mg/ml, and only 6% used e-cigarettes without nicotine. Since they started e-smoking, constant concentration of nicotine in e-liquid was indicated by 62.7% of e-smokers, 10% increased (mean 10.7±6.3 mg/ml) and 28% reduced (mean 8.5±3.5 mg/ml) nicotine content in usually used e-liquid. In case of 4.9% e-smokers e-cigarette was effective method in giving up tobacco smoking.

Conclusion: Smoking cessation was not the reason for e-cigarette use among most of the e-smokers. Almost half of e-cigarette users use high nicotine doses and do not try to reduce their nicotine content.

Back to top

Most common e-cig refills contain respiratory irritants, and people who smoke and use e-cigs are more likely to experience respiratory symptoms

13 September, 2017

Milan, Italy: Two new studies presented at the European Respiratory Society International Congress highlight the risks associated with using e-cigarettes, especially for those who also smoke conventional cigarettes.

One study examined 122 of the most commonly sold e-cigarette liquids in nine European countries and found that all contained at least one substance classified as a health risk.

The other study, a survey of more than 30,000 people in Sweden, found that e-cigarette use was most common among people who already smoke, and that people who use both experience more symptoms, such as a persistent cough, wheezing and coughing up mucus.

The research on the combined effects of smoking and e-cigarettes will be presented by Dr Linnea Hedman, a behavioural scientist at Umeå University in Sweden.

Dr Hedman and her colleagues questioned more than 30,000 people, who were randomly selected from the general population in Sweden, about their smoking habits, use of e-cigarettes and respiratory symptoms.

Around 11% of people surveyed said they only smoke conventional cigarettes, while 0.6% said they only use e-cigarettes and 1.2% said they use both. The results revealed that e-cigarette use was more common among people who currently smoke conventional cigarettes (9.8%), compared to former smokers (1.1%) or non-smokers (0.6%).

The results also showed that people who use both conventional cigarettes and e-cigarettes were the most likely to suffer with respiratory symptoms. Among non-smokers 26% experienced any respiratory symptoms, compared with 34% among those using only e-cigarettes, 46% among those only smoking conventional cigarettes, and 56% among dual users.

Dr Hedman will tell the congress: “Our results show that a proportion of smokers are also using e-cigarettes. It could be that they’re turning to e-cigarettes when they’re in places like cafes and restaurants where they cannot smoke conventional cigarettes, or it could be that they’re using e-cigarettes in the hopes of quitting smoking. One argument for e-cigarettes is that they could help smokers to quit, but our study does not support this argument. If that was the case, e-cigarette use would have been most common among former smokers.

“We have also found that people who use both conventional and e-cigarettes are more likely to suffer wheezing, or a long-standing or productive cough. It could be that some

smokers, who are already suffering these symptoms, want to quit smoking by changing to e-cigarettes but they are not managing to stop. Alternatively, it could be that using both products causes worse respiratory effects than either alone. More research is needed to determine whether e-cigarette use contributes to smoking cessation or if it increases the burden of respiratory disease.

“The possible health effects of e-cigarettes are far from established and it will take some years before the long-term effects will be revealed. However, this research adds to the evidence that e-cigarettes cannot yet be marketed as a safe alternative to conventional cigarettes.

The research on the content of e-cigarette refills was presented by Dr Constantine Vardavas (MD, PhD), from the University of Crete.

Dr Vardavas and his colleagues selected a random sample of e-cigarette liquids from the most popular brands on sale in Greece, Spain, Germany, The Netherlands, the UK, Hungary, Romania, Poland and France, which included a variety of different flavours and nicotine strengths.

They analysed each sample to find out exactly which chemicals were present and in what quantities. Every liquid they tested contained at least one substance that has some level of risk to health according to the United Nations (UN) classification system [1].

These included methyl cyclopentanolone (found in 26.3% of samples) and a-ionone (found in 8.7% of samples), both which “may cause allergy or asthma symptoms or breathing difficulties if inhaled”, according to their classification. Other substances, such as menthol (42.9% of samples), ethyl vanillin (16.5% of samples) and acetyl pyrazine (8.2% of samples), are classified as “able to cause respiratory irritation”.

Dr Vardavas told the congress: “The most recent evidence from across the European Union shows a substantial increase in e-cigarette use over the past few years. The EU Tobacco Products Directive notes that e-liquids should not contain ingredients that pose a risk to human health. However, despite growing research on the effect of different ingredients within e-liquids there is little knowledge on the impact they may have on respiratory health.

“Our research reveals that e-cigarette liquids on sale in Europe have ingredients that are potential respiratory irritants. This means that they are substances which irritate the airways according to previous research and international classification standards.

“An EU Directive on e-cigarettes rules that: ‘except for nicotine, only ingredients are used in the nicotine-containing liquid that do not pose a risk to human health in heated or unheated form’. We think the respiratory irritants we found may be a breach of this legislation.

“Based on this work, we also think users should be aware that e-cigarettes are not risk-free, and that doctors should inform their patients that e-cigarettes may contain respiratory irritants.”

In a separate study also presented at the Congress, Dr Vardavas and his team examined trends in smokers’ attempts to quit, with surveys of almost 10,000 Europeans in 2012 and in 2014. They found that use of nicotine replacement therapy declined (from 14.6% in 2012

to 12.2% in 2014) and quitting with the help of healthcare professionals and smoking cessation clinics also fell (6.7% to 5.0%). However, experimentation with e-cigarettes for the purpose of quitting increased (from 3.7% in 2012 to 11.0% in 2014).

E-Cigarettes Linked to Development of COPD

Newsroom

Regular use of electronic cigarettes is associated with increased odds of having chronic obstructive pulmonary disease (COPD), according to a study presented at a recent medical conference.

Regular use of electronic cigarettes is associated with increased odds of having chronic obstructive pulmonary disease (COPD), according to a study presented at a recent medical conference.

Electronic cigarette use is rising in the United States, alarming public health officials. Other studies have shown links between electronic cigarettes and asthma in youths, and in vitro and animal studies have shown an inflammatory response to electronic cigarettes similar that observed with conventional cigarettes.

The latest study, shown in a poster session at the American Thoracic Society 2018 International Conference, examined the association between electronic cigarettes and COPD in adults.

The study included 32,247 adults from the Population Assessment of Tobacco and Health (PATH) study, a national longitudinal study of tobacco use undertaken by the FDA and the National Institutes of Health. Of that pool, 1575 adults met the criteria for electronic cigarette use.

Electronic cigarette use was defined as using the device every day or some days. The prevalence of COPD was defined as having either emphysema, chronic bronchitis, or COPD.

Propensity score matching was used to balance potential confounders (eg, use of other tobacco products or secondhand smoke) between the electronic cigarettes and nonelectronic cigarette users. The propensity-matched group was composed of 1321 electronic cigarette users and 1321 nonelectronic cigarette users.

The prevalence of COPD among electronic cigarette users was 4.45% (95% CI, 3.70%-5.19%).

Electronic cigarette users were more likely to have COPD (odds ratio [OR], 1.86; 95% CI, 1.22-2.83).

The results showed that fairly regular use of electronic cigarettes every day or some days is associated with increased odds of having COPD, even after adjusting for potential confounding factors.

The researchers said it is unknown whether electronic cigarettes could contribute to COPD development or if people who have COPD are more likely to use electronic cigarettes (possibly as a harm reduction method).

Reference

Perez MF, Atuegwu N, Mead E, Oncken C, Mortensen EM. E-cigarette use is associated with emphysema, chronic bronchitis and COPD. Poster presentation at: American Thoracic Society 2018 International Conference; May 18-23, 2018; San Diego, CA. Poster 402.

E-Cigarette Smoke Poses Threat to DNA Repair Activity
States With Strict Tobacco Regulations Have Lower Incidence of E-Cigarette Users
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E-Cigarette Smoke Poses Threat to DNA Repair Activity

Newsroom

Kaitlynn Ely

E-cigarette smokers have a high risk of developing lung and bladder cancer, as well as certain heart diseases due to carcinogenic e-cigarette smoke (ECS), according to a study published in the *Proceedings of the National Academy of Sciences*.
E-cigarette smokers have a high risk of developing lung and bladder cancer, as well as certain heart diseases due to carcinogenic e-cigarette smoke (ECS), according to a study published in the *Proceedings of the National Academy of Sciences*.
E-cigarettes were developed as a tool for tobacco smokers to receive nicotine without the harmful effects of burning tobacco. This would be a way to reduce their smoking habits and their addiction to nicotine. However, 18 million people have started to smoke e-cigarettes as they are considered a healthy way to quit smoking.

The researchers measured the carcinogenicity of ECS and compared it to tobacco smoke (TS) to observe if there is DNA damage created by ECS. Mouse models were used to measure DNA damage and repair while the effect of ECS on the susceptibility to mutations on cultured human cells.

Twenty mice were split into 2 groups and exposed to ECS (10 mg/mL, 3 hours/day, 5 days/week) for 12 weeks. This dosage amount and length of time is equivalent in human terms to light e-cigarette smoking for 10 years. Two major DNA-repair mechanisms in mouse lung tissues were examined: nucleotide excision repair (NER) and base excision repair (BER). It was found that in the lung tissues of ECS-exposed mice had significantly lower levels of NER and BER than filtered air-exposed mice.

Nicotine is unable to bind to DNA, yet the inhaled nicotine-derived nitrosamine ketone (NNK) is metabolized into methyldiazohydroxide (MDOH) which can methylate deoxyguanosines and thymidines in DNA. In humans, it was shown that metabolites of nicotine and NNK mutate DNA-repair proteins and affect DNA-repair activity and repair protein levels in human lung and bladder epithelial cells.

While nicotine is not carcinogenic, large amounts of the stimulant turn into tobacco-specific nitrosamines (TSA), like NNK, through nitrosation. TSA have proved to be carcinogenic in animal models. Nitrosation occurs in the human body when ECS is inhaled, putting e-cigarette smokers at risk for inhaling carcinogens.

“We also found that nicotine and NNK can enhance mutational susceptibility and induced tumorigenic transformation of human lung and bladder epithelial cells,” the authors concluded. “Based on these results, we propose that ECS is carcinogenic and that [e-cigarette] smokers have a higher risk than nonsmokers to develop lung and bladder cancer and heart diseases.”

References

Lee HW, Park SH, Weng MW, et al. E-cigarette smoke damages DNA and reduces repair activity in mouse lung, heart, and bladder as well as in human lung and bladder cells. *Proc Natl Acad Sci*. 2018. Published online ahead of print January 29, 2018.

E-cigarettes leak toxic metals, study finds

medicalnewstoday.com/articles/321006.php

By Maria Cohut

Several recent studies have suggested that electronic cigarettes may not be as safe as we may think, and a new study now adds that these popular devices leak harmful metals — some of them highly toxic.

New research suggests that toxic metals leaking from e-cigarettes could endanger health.

Ever since their release on the global market, electronic cigarettes (e-cigarettes) have been hailed, generally, as a safer alternative to the regular ones.

These devices work by heating up a flavored liquid that sometimes — though not always — contains nicotine.

Instead of smoke, e-cigarettes release aerosols, or "vapors," which is why users of e-cigarettes are often referred to as "vapers," and the act of "smoking" using this device is dubbed "vaping."

Despite the popular belief that e-cigarettes are better for our health than traditional ones, recent research has indicated that these devices could bring about fresh, and little understood, risks.

It has been suggested that people who use e-cigatattes could have a higher risk of cardiovascular problems and cancer, and a study published earlier this month found that a few certain e-cigarette flavors are particularly toxic.

Now, a team of scientists from the Johns Hopkins Bloomberg School of Public Health in Baltimore, MD, concludes that e-cigarette vapors could also be harmful. Senior study author Ana María Rule and team surmise that the danger may arise from the toxic content of e-cigarette heating coils.

> "It's important for the FDA [Food and Drug Administration], the e-cigarette companies, and vapers themselves to know that these heating coils, as currently made, seem to be leaking toxic metals — which then get into the aerosols that vapers inhale."
>
> Ana María Rule

The researchers' findings are now published in the journal *Environmental Health Perspectives*.

Concentration 'higher than safe limits'

In a previous study, Rule and colleagues identified a series of toxic metals — cadmium, chromium, lead, manganese, and nickel — in e-cigarette liquids.

The new research took these findings and went further, testing the e-cigarettes of actual users in order to try to understand how exposed people were to these toxic substances, and under what circumstances.

Rule and team worked with 56 participants who used e-cigarettes on a daily basis. The researchers tested the participants' e-cigarettes, verifying the presence of 15 metals in the refilling dispensers, the vaping liquids "loaded" into the e-cigarettes, and the vapors that resulted from the liquids' heating.

The researchers were able to confirm that toxic metals were present in the e-liquids from refilling dispensers, though in fairly small concentrations. But a completely different story unfolded in the case of tank-filling solutions that had already been heated by the inbuilt coils.

These e-liquids had much higher concentrations of toxic metals, which — the researchers say — suggests that the solutions themselves are not the source of these substances. Instead, Rule and colleagues infer that the toxic metals may come from the heating coils.

Due to the contamination of the e-liquid, traces of toxic metals were also found in the aerosols released by the e-cigarettes.

The metals that the study's authors express most concern about are lead, chromium, nickel, and manganese, all of which have been linked with important health risks, including

cancer, brain damage, and disorders of the respiratory system.

In aerosols, the median concentration for lead alone was around 15 micrograms per kilogram, and 48 percent of the vapor samples that the team tested had lead concentrations that exceeded the limit recommended by the United States Environmental Protection Agency.

"These were median levels only," says Rule. "The actual levels of these metals [including those of nickel, chromium, and manganese] varied greatly from sample to sample, and often were much higher than safe limits."

Mysterious sources of toxic metals

As previous research has confirmed, the heating coils contained in e-cigarettes are often made of a combination of nickel and chromium, plus other substances. This supports the thesis that many of the toxic metals whose traces were found in e-liquids and aerosols must have leaked from those coils.

However, it remains unclear where the lead is coming from, or how all of these metals contaminate the e-liquid.

"We don't know yet whether metals are chemically leaching from the coil or vaporizing when it's heated," says Rule.

Study co-author Angela Aherrera also led a separate investigation using data from the same 56 participants. Her additional inquiry revealed that the e-cigarette users had increased levels of nickel and chromium in their urine and saliva.

These were consistent with the concentration of these metals identified in e-cigarette vapors.

Interestingly, however, toxic metal traces were found in higher concentrations in vapors produced by e-cigarettes whose heating coils were frequently replaced.

This suggests that the leaks likely occur from new heating coils, and perhaps less so in the case of older elements.

Another worrying result indicated that arsenic — a highly toxic substance — was found in refill e-liquid, tank liquid, and vapors in no fewer than 10 out of the 56 sets of samples provided by the study participants. Why arsenic was present remains to be clarified.

"We've established with this study that there are exposures to these metals, which is the first step," says Rule, adding that there is a "need also to determine the actual health effects."