

E-cigarettes vs. Conventional Cigarettes and their Health Effects on the Environment

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Introduction

The rate of smoking has been declining in the United States, but the new discovery of e-cigarettes might cause an increase once again. E-cigarettes have been on the rise especially in adolescents because of the easy accessibility due to the lack of regulation. These devices are appearing more frequently in gas stations, convenience stores, kiosks in malls, and anywhere else cigarettes are sold. E-cigarette companies offers its users flavorings that differ from tobacco such as bubblegum and cotton candy. Users can also modify their e-cigarettes to produce more smoke and expand the cartridges that contains the nicotine. Decades of studies and research have indicated that smoking is harmful to the body as well as to the environment. The new rise of the e-cigarettes could impose another problem onto the environment. E-cigarettes still have health risks associated to it and could prove to be worse than regular cigarettes. Although e-cigarettes are reduced in the amount of carcinogenic properties, they are still present. The question still stands whether or not e-cigarettes are a safer alternative to conventional cigarettes.

What are e-cigarettes?

E-cigarettes entered the market in 2007 since the creation by a Chinese pharmacist, Hon Lik, who developed an alternative to traditional cigarettes. The devices come in a variety of shapes and sizes, but all made for one general purpose (Arnold, 2014). The difference between e-cigarettes and regular cigarettes is that e-cigarettes are battery-operated devices that are designed to deliver nicotine with flavorings to users in vapor instead of smoke. The vaporization of the drugs from liquid form is inhaled, as opposed to inhalation via combustion of tobacco (Williams, 2014). E-cigarettes consist of three different components, a cartridge which holds the liquid solution containing various amounts of nicotine, flavorings, and other chemicals, a heating device which causes the vaporization, and the power source that is usually a battery. In many

devices, puffing activates the battery-operated heating device, which vaporizes the liquid in the cartridge, and results in the aerosol or vapor that is inhaled through a mouthpiece. This action is then called “vaping” (“DrugFacts: Electronic Cigarettes (e-Cigarettes)”, 2015).



Figure 1: Images of people using e-cigarettes in public settings

The effect of e-cigarettes on the population

Since the invention, an estimated of 250 e-cigarette brands have become available in the United States. The use has double among adults from 2010 to 2011, in other words, from 3.3% to 6.2%, or about 15.5 million people (DeAngelis, 2014). The Centers for Disease Control and Prevention state that more than a quarter-million youth who had never smoked a cigarette used e-cigarettes in 2013 according to a study published in the Journal of Nicotine and Tobacco Research. The number reflected a three-fold increase, from about 79,000 in 2011 to more than 263,000 in 2013. Youths who used e-cigarettes but not conventional cigarettes had higher intentions to smoke conventional cigarettes than those who had never used e-cigarettes (“More than a quarter-million youth who had never smoked a cigarette used e-cigarettes in 2013”, 2014). E-cigarettes have become increasingly popular among adolescents, and is mostly due to the lack of regulation. Although the devices contain nicotine derived from tobacco, they are not yet subject to regulation as tobacco products. In addition, there is no regulation or requirement that

purchases must be of a certain age. In some states, bans of minors purchasing e-cigarettes have been passed, but loopholes such as buying the device online are still an option. Their easy availability, whether online or at mall kiosks, and the wide array of cartridge flavors such as mint, candy, and fruit flavors, make the device visually appealing to the age group (“DrugFacts: Electronic Cigarettes (e-Cigarettes)”, 2015). Arnold (2014) stated that in 2012, an estimated 1.78 million students in grades 6-12 had tried the device. Recent accusations have been thrown at manufacturers for advertising and appealing to youths by using flavors as a marketing strategy to attract young users.

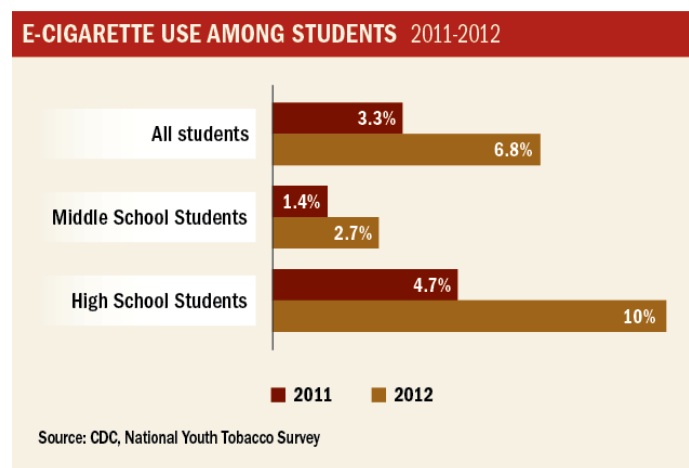


Figure 2: Statistics on e-cigarette use among students

Hidden dangers of e-cigarettes

Smoking cigarettes still remains as the leading preventable cause of sickness and mortality, and responsible for over 400,000 deaths in the United States each year. Health effects such as cancer and heart disease have been linked to inhalation of tar and other chemicals produced by tobacco combustion. E-cigarettes, on the other hand, appear to be “safer”, and a less toxic alternative to conventional cigarettes because they deliver nicotine without burning tobacco and with less toxic chemicals. Although they do not produce tobacco, e-cigarettes still contain

nicotine and other harmful chemicals such as formaldehyde and acetaldehyde as well as potentially toxic metal nanoparticles from the vaporizing mechanism. Concerns have been shown whether or not these devices could become a gateway or the cartridges could be filled with other substances other than nicotine, thus possibly serving as a “new and potentially dangerous way to deliver other drugs” (“DrugFacts: Electronic Cigarettes (e-Cigarettes)”, 2015). Evidence has shown that nicotine’s adverse effects on an adolescent brain development could result in lasting deficits in cognitive function. About three out of every four teen smokers become adult smokers, even if they were to quit in a few years (“More than a quarter-million youth who had never smoked a cigarette used e-cigarettes in 2013”, 2014). The freebase form of nicotine is created due to the heating from the devices and makes it more addictive. The freebase form of nicotine travels directly into the lungs, and then quickly absorbed into the blood stream where it is delivered to the teen’s brain. The Journal of Adolescent Health reported that teen use of e-cigarettes had no cessation benefits for teens who were current tobacco users, and that was strongly associated with heavier cigarette smoking. It stated that “adolescents who tried to quit smoking are more likely to use e-cigarettes but less likely to no longer smoke, which suggests that e-cigarettes inhibit rather than promote cessation” (Williams, 2014).

Studies and Research

A study from the Nicotine & Tobacco Research revealed potentially toxic carbonyl formation when e-cigarettes are heated to high temperatures. Users can now upgrade and modify their e-cigarettes, with some models having variable voltages, allowing users to increase the temperature of the heating element to deliver more nicotine, and generating carbonyls at the same time. Formaldehyde, acetaldehyde, acetone, and butanol were also among the listed of chemicals produced (Arnold, 2014).

Comparison of sample toxicants emitted by tobacco cigarettes and e-cigarettes			
Toxic compound	Tobacco cigarette (µg in mainstream smoke)	E-cigarette (µg per 15 puffs*)	Average ratio (conventional vs electronic cigarette)
Formaldehyde	1.6-52	0.20-5.61	9
Acetaldehyde	52-140	0.11-1.36	450
Acrolein	2.4-62	0.07-4.19	15
Toluene	8.3-70	0.02-0.63	120
NNN**	0.005-0.19	0.00008-0.00043	380
NNK**	0.012-0.11	0.00011-0.00283	40

* The authors assumed smokers of e-cigarettes would take an average of 15 puffs per vaping session, corresponding to smoking one tobacco cigarette.
 ** Tobacco-specific nitrosamine, a carcinogenic compound that originates in the curing and processing of tobacco.
 Adapted from Goniewicz et al. (2014)⁴

Figure 3: The comparison of toxins emitted by tobacco cigarettes and e-cigarettes

Formaldehyde, a known carcinogen, can be produced in high concentrations in e-cigarette vapor. David Peyton, a chemistry professor at Portland State University, helped conduct the research on the safety of e-cigarettes, reported that masked formaldehyde were found in liquid droplet particles of the vapor. Peyton reported that this form of formaldehyde were at significantly higher concentrations than regular cigarettes. These findings were between five to fifteen fold higher in concentration of formaldehyde than in cigarettes (Stein, 2015). Although the study was done on the highest voltage setting, many e-cigarette users set to low levels, but it is suggested that users will tend to use high settings. Long-term exposure of this chemical along with other carcinogenic properties would contribute to lung cancer. A cell biologist in 2013 at Prue Talbot of the University of California, Riverside, found nanoparticles in the vapor from e-cigarettes. An analysis revealed that there were high concentrations of heavy metals and silicates. The metal nanoparticles came from the heating element, which consisted of a nickel-chromium wire coated in silver and soldered with tin. During the exposure with the heating element, the e-liquid appeared to pick up bits of metal, and then carried into the aerosol (Arnold, 2014).

Despite the lack of supporting data or environmental pact studies, some manufacturers claim that their products are “eco-friendly” or “green,” but many suggest that this might just be a marketing strategy. E-cigarettes pose a potential impact to indoor air quality as well as potential

exposure to second-hand e-cigarette aerosol. The World Health Organization (WHO) has recommended the restricted use of e-cigarettes in public spaces, similar to that of regular cigarettes. E-cigarettes contribute secondhand aerosol to the environment only by emitting particles as they are exhaled by the user. Regular cigarettes, on the other hand, produce secondhand smoke through side-stream smoke along with particles exhaled by the smoker (Chang, 2014). Although the studies are still ongoing, e-cigarettes may expose bystanders to emissions. Arnold (2014) stated that a group of researchers observed increased indoor air levels, albeit less than those associated with regular cigarettes, of coarse particulate matter, polycyclic aromatic hydrocarbons, and aluminum following indoor vaping sessions lasting two hours each. Kevin Chatham-Stephens, an officer with the Epidemic Intelligence Service at the Centers for Disease Control and Prevention, published the first data on child exposures to e-cigarettes and their components. The reports increased from 1 call in September 2010 to 215 in February 2014. Just over half of the reported e-cigarette exposures were to the e-liquids or the vapor. It was pointed out that nicotine solution at a certain strength used in some refill cartridges could be lethal if ingested (Arnold, 2014). It is also unclear on the disposal of these devices. Most of the labeling on these products do not indicate a proper way to dispose of the parts of the e-cigarette, including the cartridge, batteries, and atomizers. E-cigarettes are not a pharmaceutical product, therefore, the disposal is not regulated under the Resource Conservation and Recovery Act (RCRA) or any other program. This meant that the unused and the used cartridges containing residual nicotine could be disposed of without treatment to remove nicotine (Chang, 2014).

Analysis

Unlike regular cigarettes, e-cigarettes might yet prove to be more eco-friendly despite the lack of research and its relatively new introduction into the market. The lack of studies done still

show further potential health risks associated with the use of e-cigarettes and the vapors that are distributed into the air and inhaled. One benefit that has been proposed is that e-cigarettes could help decrease the amount of cigarette butt litter that is still ever so present. These cigarette butts are left behind by smokers along sidewalks, roads, parking lots, and often a few feet from the trash can. Cigarette butts are still a significant trash problem, and can affect any organism that comes into contact with them because of the chemical properties that remains. The butts are pushed into storm drains and float out into the ocean, where they can release toxic chemicals, or get eaten by fish or birds (Howard, 2012). Since e-cigarettes can be re-usable and are powered by batteries or charged by USB ports, they could help reduce the toxic burden on the environment. The issue of secondhand smoke is still debatable. Although e-cigarettes will reduce the amount secondhand smoke, it is still present, and the vapors contain nanoparticles of metal that could be inhaled by bystanders. The marketing strategies and the lack of regulation on e-cigarettes draw many criticisms from parents and the community because these products are catching the attention of children. E-cigarettes could become “gateways” to traditional smoking for kids who have never smoked before. Regulations of e-cigarettes should be put in place to avoid minors from smoking, and prevent further exposure to these toxic chemicals at a young age. Since e-cigarettes don’t produce smoke, they are much less risky to non-users and to the air quality, but that does not mean there are hidden risks behind the use. Whether or not e-cigarettes will assist in cessation of smoking or interfere with quitting are still being questioned. Because of the lack of studies, it is hard to determine whether there are any therapeutic benefits or how the health effects compare to conventional cigarettes.

Conclusion

Are e-cigarettes a safer alternative for conventional cigarettes? The answer is still uncertain, but the use of e-cigarettes could prove to be “safer” in general terms. E-cigarettes would help in the reduction of cigarette butt litter because they are reusable and rechargeable. Since e-cigarettes do not produce smoke, its impact on the air could be lessened, unlike regular cigarettes that produce secondhand smoke. The lack of studies and research restrict the amount of knowledge that is known about these products. Because the devices are relatively new to the market, they pique interests of many people especially to children. Their designs and flavored e-liquids catch the attention of children and introduce them into smoking early as well as providing a gateway into using tobacco and drugs. This proves to be detrimental to their health because adolescents exposed to these chemicals could harm their body and brain for the long term. More and more manufacturers and vendors are emerging, creating their own version of the e-liquid and modifications. This poses a risk because there is no uniformity in the creation and each e-liquid could contain different amounts of chemicals. Since these devices are not regulated and sold easily, they could become a huge health risk.

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