

Johns Hopkins researchers find toxic levels of heavy metals in e-cigarette vapors

Benjamin Mateus
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A recently published study in the *Journal of Environmental Health Perspective* studying the impact of electronic cigarettes (e-cigarettes) on daily users reported that the heating coils in these devices cause the release of toxic heavy metals in the vapors being inhaled.

E-cigarettes have been growing in popularity as a substitute for tobacco and method for smoking cessation despite uncertainties regarding their impact on the health of users. The device generates nicotine and non-nicotine containing vapors through a process where the e-liquid solution (these contain propylene glycol, glycerin, water, nicotine, and flavorings) is heated by metallic coils.

Two commonly used alloys in manufacturing these coils include Kanthal—made of iron, chromium, and aluminum which have a wide range of resistance and high-temperature application—and Nichrome, made of nickel and chromium.

Exposure to these toxic metals including the lead in the e-liquid solution has the potential for considerable health consequences. Lead has been known to cause neurotoxicity and cardiovascular disease while nickel and chromium have been implicated in respiratory ailments.

The reusable e-cigarettes come with a cylindrical-shaped battery and a mouthpiece that has a tank to refill with the e-liquid. These devices have diverse voltages and coil composition as they can be assembled and manipulated by the user.

Fifty-six participants were recruited into the study. The information recorded included the type of device used, the voltage of their device, type of coil, and frequency of coil changes. They collected three types of samples: the e-solution before contact with the coils, the aerosol generated by the e-cigarette, and the e-

solution remaining in the tank after vaping.

The increase in metal concentrations in the aerosol/vapor and residual in the dispenser when compared to the e-liquid were all statistically significant for aluminum, cadmium, chromium, copper, iron, manganese, nickel, lead, antimony, tin and zinc. The ratio-increase for zinc was 29.5 in the aerosol and 36.7 in the tank; lead 25.4 and 116; nickel 8.43 and 64.6; chromium 6.78 and 70.7. The authors also pointed to concerns about arsenic in 10.7 percent of the e-liquid dispensers as those appear to get transferred to the aerosol and the tank as well. They attribute the source of most of these toxic metals to the heating coils in the e-cigarettes while the lead and arsenic appear to come from the dispensers of the e-solution.

According to standards established by the Agency for Toxic Substances and Disease Registry (ATSDR), 57 percent of e-cigarettes exceed the daily chronic Minimum Risk Level (MRL) for nickel, 68 percent exceed the daily MRL for chromium hexavalent, while for lead 48 percent exceed the EPA National Ambient Air Quality Standards. The authors also note that their data on the aerosol concentrations may be an underestimation as they assumed daily exposures as equivalent to 50 puffs, whereas recent investigation indicates that the average is closer to 200 puffs per day.

Interestingly, a study from 2017 found that e-cigarettes contained 35 of 36 elements and metals they screened for while only 15 of these were detected in conventional tobacco smoke. Some of these elements were present in much higher concentrations in e-cigarettes than in tobacco. They attributed these elements and particles to the filaments, thick wire, brass clamp, solder joints and wick and sheath of the e-cigarette devices.

The findings of the present study suggest that using e-

cigarettes instead of tobacco results in less cadmium exposure but not to other hazardous material found in tobacco. They noted that emission rates were higher for cadmium, chromium, and nickel in e-cigarettes while lead and zinc seemed to be in similar concentration ranges with tobacco cigarettes.

The exposure to lead is of significant concern as decades of data suggest no observable lower threshold that can be considered safe and therefore all lead exposure should be avoided. Also, chromium and nickel are considered to have high carcinogenic potential (cause cancers). Iron can cause respiratory irritation and lead to lung fibrosis. Manganese can cause chronic bronchitis and reduced lung function as well as neurological dysfunctions. Copper may lead to coughing, chest pain and chronic nasal drip. Zinc can lead to shortness of breath, coughing and chest pain from reduced lung functions. Arsenic has the potential to cause cancer and cardiovascular diseases.

In a recent 2017 survey conducted on “vaping” by the NIH, they noted that one in three students in the 12th grade said they had used some vaping device in the last year. In December 2017, almost 7 percent of eighth graders, 13 percent of 10th graders and 17 percent of high school seniors reported having vaped in the past month.

More than 2 million middle and high school students were current users of e-cigarettes in 2016. This translates to 11 percent of high school and 4.3 percent of middle school students in the United States considered current users. From 2011 to 2015 e-cigarette use rose from 1.5 percent to 16 percent among high school students. Despite the recent studies that have exposed the potential health hazards of e-cigarettes the Food and Drug Administration (FDA) remains on the fence as to how to regulate e-cigarettes. Currently, they are treated under the Family Smoking Prevention and Tobacco Control Act as equivalent to tobacco products, which means they regulate the marketing, labeling, and manufacturing of devices and e-liquids. Even according to the FDA review published in 2014, they admitted that e-cigarettes not only contain varying levels of nicotine, but also of potentially harmful nitrosamines, aldehydes, metals, volatile organic compounds, phenolic compounds and other substances.

The e-cigarette was invented in 2003 by a Chinese pharmacist and was first sold in 2004. The e-cigarette

market, which includes more than 250 brands, saw exponential growth in 2006 with several million users worldwide and every major tobacco company engaged in the manufacturing and selling of these devices. Industry experts believe the consumption of e-cigarettes will surpass conventional tobacco cigarettes in the next decade.

As of 2018, operating profit pools for e-cigarettes was over \$4 billion. It is estimated that by 2022 that figure will exceed \$12 billion and surpass those of tobacco cigarettes. An April 2015 analysis published in the *American Journal of Public Health* found that smokers who used e-cigarettes were 59 percent less likely to quit smoking than those who never smoked e-cigarettes. The authors concluded that there was no compelling scientific evidence that e-cigarettes were better than nicotine patches, prescription drugs or behavioral techniques in helping smokers quit.

What is alarming is the number of youth who have turned to vaping without understanding the consequences of this activity to their long-term health. The more important but seemingly rhetorical question is to ask why these corporations do not test the safety of their products before bringing them to market. The profit motive is the most plausible explanation.



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