

ScienceNews*for*Students

TOXICOLOGY HEALTH BEHAVIOR

Concerns explode over new health risks of vaping

Researchers link e-cigs to wounds that won't heal and 'smoker's cough' in teens

BY LINDSEY KONKEL APR 25, 2017 — 7:10 AM EST



Vaping is not risk-free, especially for kids and teens. A host of new studies have now uncovered worrisome health concerns. For instance, the atomizer shown here can make vapors hotter and riskier to health.

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When Irfan Rahman talked to young vapers, some complained of bleeding mouths and throats. And these bloody sores seemed slow to heal. Such reports concerned this toxicologist at the University of Rochester in New York. So he decided to investigate what the vapors inhaled from electronic cigarettes might be doing to mouth cells.

Last October, his team showed those vapors inflame mouth cells in ways that could potentially promote gum disease. That gum damage can destroy the tissues that hold teeth in place. So severe gum disease could lead to tooth loss.

But that's hardly the end of it.

Vapers inhale those same gases and particles into their lungs. Rahman wondered what effects those vapors might have on cells there. One gauge would be to test how long any lung-cell damage took to heal. And his latest data confirm that e-cigarette vapors also make it hard for lung cells to repair damage.

Students as young as 12 or 13 are now more likely to vape than to smoke. Many are under the impression that because e-cigs don't contain tobacco, they pose little risk to health. Wrong.

Over the past few months, research has turned up evidence that vaping can pose many brand new risks. The vapors mess with immunity, some studies show. "Smoker's cough" and bloody sores have begun showing up in teen vapers. The hotter a vaped liquid gets, the harsher its effects on human cells. And a relatively new vaping behavior called "dripping" ups the heat. This threatens to intensify a teen's risks from those vapors.

Some new data even suggest that e-cig vapors may contain cancer-causing chemicals.

"There are a lot of potentially harmful substances in e-cigarettes. If you're a teen with your whole life in front of you, why take that risk?" asks Rob McConnell. He's an internal medicine specialist at the University of Southern California (USC) in Los Angeles.

The newly emerging data suggest that adolescents ignore these risks at their peril.

Impaired wound healing

Cells in the body face constant damage from foreign substances, infections and injury. Most times, nothing bad happens to their host. That's because the body has a system in place to heal itself. Most major organs have special cells — fibroblasts (FY-broh-blasts) — that repair damaged or injured tissue.

Fibroblasts make up the connective tissues that keep organs in place. But when injured, these cells morph into wound-healers. "If you cut your hand, fibroblasts are the guys that are going to come in and help heal it," explains Rahman.

In their wound-healing form, fibroblasts at the edges of a cut will shrink. This causes the wound to close up. This squeezing or contraction of the skin takes a lot of energy. Fortunately, fibroblasts are powered by cellular engines. Called mitochondria (My-toh-KON-dree-uh), these tiny powerhouses turn food (sugar) into fuel.

In the lab, Rahman and his colleagues grew lung fibroblasts in *Petri dishes*. Then they cut into the community of growing cells to mimic a wound. Afterward, they exposed the growing cells to e-cigarette vapors.

As expected, the fibroblasts morphed into wound-healing cells. But unexpectedly, they didn't close up the cut. Curious, Rahman looked more closely at the cellular machinery. Some mitochondria had been destroyed. The fibroblasts simply had run out of the energy they needed before they could successfully squeeze the wound closed.

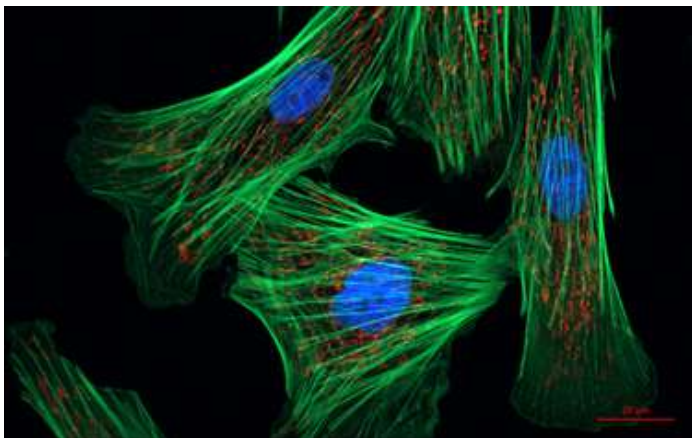
Rahman's team described its findings March 3 in *Scientific Reports*.

It's not clear yet if the fibroblast damage that Rahman showed in the lab signals that wounds will heal more slowly in people who vape. After all, in the lab, scientists can manipulate one variable

Explainer: What are e-cigarettes?

(<https://www.sciencenewsforstudents.org/article/explain>

[what-are-e-cigarettes](https://www.sciencenewsforstudents.org/article/explain-what-are-e-cigarettes))



Fibroblast cells (such as those seen here) repair damaged or injured tissues. The cells' nuclei are colored blue. Their mitochondria are red. Filaments (green) help the fibroblast contract.

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Bronchitis may cause wheezing, too, and coughs that bring up thick mucus known as phlegm (FLEM). The germs that cause colds, flu and bacterial infections can sometimes trigger bronchitis. So can breathing in heavily polluted air, tobacco smoke or certain chemical fumes.

When these symptoms don't go away, the bronchitis is called *chronic* (KRON-ik). And cigarette smoking is its most common cause. That's why chronic bronchitis is typically referred to as "smoker's cough."

McConnell's team decided to look for signs of bronchitis in vaping teens. After all, he explains, "There are a lot of these irritants in e-cigarette vapor."

The researchers asked 2,000 students in the Los Angeles, Calif., area about their vaping habits. All were in their last two years of high school. The researchers also asked the teens about any respiratory symptoms. These could include coughs or phlegm.

Anyone who reported a daily cough for at least three straight months was judged to have chronic bronchitis. A student with persistent phlegm or congestion for three months or more that was *not* accompanied by a cold or flu also was suspected of having chronic bronchitis.

About 500 of the students said they had vaped at some point. And about 200 had vaped within the past 30 days. Those recent vapers were about twice as likely to have chronic bronchitis as

at a time while holding other factors constant. But in the body, many processes will be at work all at once. This can make it harder to tease out whether such lab tests mimic well what would happen to an otherwise healthy person.

And that's why Rahman now hopes to compare rates of wound healing in people who vape to rates in those who don't. For now, however, he's worried that what he saw in the lab may indeed mimic risks to people.

Smoker's cough becomes vaper's cough?

Inhaling pollution can irritate the lungs. And when the assaulting particles are breathed in regularly, the lungs tend to respond by triggering a cough that won't go away, explains McConnell at USC. He has been studying the effects of air pollution in kids. Inhaling irritating particles or gases may lead to bronchitis (Bron-KY-tis). That's when the airways that channel oxygen to the lungs become irritated and inflamed.



Researchers have found evidence that vaping can irritate the lungs and lead to chronic wheezing and coughs, a condition known as bronchitis.

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were kids who had never vaped, the researchers report. Students who had vaped in the past, but *not* in the last month, also were about as likely as current vapers to have chronic bronchitis.

The researchers looked for other possible causes of the teens' persistent coughs and phlegm. One of these was local air pollution. They also looked at the teens' exposure to triggers for allergic *asthma*. Such triggers can include molds and pet dander. Yet even accounting for all of that did not erase the link between vaping and chronic bronchitis.

The findings, first announced in November, will appear in an upcoming issue of the *American Journal of Respiratory and Critical Care Medicine*.

These data also support what has been seen in studies conducted in human and animal cells, Rahman notes.

It worries McConnell that vapers show some of the same lung symptoms as cigarette smokers. It also worries him that more teens are taking up vaping. E-cigarette use grew an astounding **900 percent** (<https://www.sciencenewsforstudents.org/article/high-school-vapers-often-become-heavy-smokers>) among high school students between 2011 and 2015.

Cigarette smokers with chronic bronchitis often develop permanent lung damage as they get older. Researchers don't know yet whether long-term vapers will too.

"People haven't been using e-cigarettes long enough to answer that question," observes McConnell. E-cigarettes have been available in the United States only since 2007.

Teens lured by fruity flavors

A third new study investigated the role of flavor in e-cig use, especially by teens.

E-cigarettes don't burn tobacco as true cigarettes do. Yet they still are considered tobacco products. That's because the liquids that are vaporized in e-cigarettes usually contain nicotine. It's the addictive substance found in tobacco leaves — one that also gives cigarettes their stimulant effect, or "buzz."



Vaping liquids can come in many pleasing flavors, which can make e-cigarettes more appealing to kids and teens, scientists warn.

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A team of researchers led by Li-Ling Huang at the University of North Carolina (UNC) in Chapel Hill wanted to know whether the e-liquid's flavor affected how safe people thought vaping was. To do this, they reviewed 40 studies on flavored tobacco products. These included flavored e-cigs. Most of the studies had been conducted between 2010 and 2016.

Both tobacco users and non-users said tobacco products were more appealing when the products had pleasing flavors. Younger people were particularly interested in fruity and candy-flavored products. In fact, this is one reason the U.S. Food and Drug Administration in 2009 banned cigarettes flavored with anything but menthol. It was to limit their appeal to kids.

"It turns out that an interest in flavors is one of the main reasons that youth try e-cigarettes," says Adam Goldstein of UNC. An author of the new study, his past work had focused on tobacco use.

Teens also tended to perceive pleasantly flavored products as less harmful than tobacco-flavored ones, his team's data show. Their findings are due to appear in an upcoming issue of *Tobacco Control*.

Goldstein says it's important to note that just because something doesn't taste like tobacco doesn't mean it is safe. Studies have shown that some flavor compounds in e-liquids (such as cinnamon extract) appear to become harmful when heated in an e-cigarette.

Review studies like this one point to potentially important trends. Such studies may help shape new policies, Goldstein says. (Policies are actions taken by government, companies or other large groups.)

Goldstein believes that removing flavorings would be one way to discourage kids from experimenting with e-cigs. "Research suggests that if you remove the flavors, far fewer youth around the country would use any tobacco product," he says. And that would put fewer kids at risk for vaping-related damage to the mouth and lungs.

Toxic metals in e-liquids

At the heart of every e-cigarette is a metal coil used to heat up the flavored e-liquid that will become a vapor. Scientists have found a number of harmful chemicals in e-cigarette vapors. Some can cause cancer. Among these are formaldehyde (For-MAAL-de-hide) and acetaldehyde (Ass-et-AAL-de-hide). Previous studies had shown that some e-liquids that were considered harmless could become toxic — but only after they were heated by an e-cig's especially hot coil.

Now Catherine Hess of the University of California, Berkeley, and her colleagues have turned up traces of toxic metals in the e-liquids used in five different brands of e-cigarettes. Those liquids came packaged from the manufacturer in non-refillable e-cigs. The scientists chose to look at these "first-generation" e-cigarettes because they are inexpensive, which can make them especially attractive to teens.

The most concerning of these metals were nickel, chromium and manganese. The amounts of them varied between brands. All three metals occur naturally in rock formations all over the planet. Inside the body, though, they can cause trouble. Research suggests that nickel and certain forms of chromium may cause cancer. Manganese can harm the nervous system.

The researchers measured only the amount of toxic metals in the e-liquids, not how much ended up in the vapor. "More research is needed to see whether e-cigarette users are being exposed to these chemicals when they inhale — and what the long-term effects of those exposures might be," says Rahman, who was not involved in this study.

Hess's team published its results in the January *Environmental Research*.

Another new study turned up benzene in e-cig vapors. This chemical is known to pose a cancer risk to people. Chemist James Pankow and his team at Portland State University in Oregon don't know the chemical's source. Benzene is, however, a toxic component of cigarette smoke. The



Scientists have found toxic chemicals in the vapors of some e-cigarettes and toxic metals in some liquids that would be vaped.

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levels in e-cig vapors were not as high as in cigarette smoke. Still, Pankow argues, that does not mean that vaping poses little benzene risk.

“The fact that vaping can deliver benzene levels many times higher than those found in the ambient [air] — where it’s already recognized as a cancer risk — should be of concern to anyone using e-cigarettes,” he says. Higher-power e-cigs, which burn hotter, produced the most benzene in the Portland State tests. So, Pankow now urges, “Please stay away from high power if it’s available on your device.”

His team published its findings March 8 in the journal *PLOS ONE*.

Concerns about dripping

Newer-generation e-cigs allow users to choose — and change — what flavorings they heat up in their devices. Most vapers choose a liquid with nicotine (that addictive, stimulant found in tobacco). To get the biggest nicotine hit from each puff, some vapers take the outside cover off of their e-cigarette and use an eyedropper to “drip” the liquid directly onto the device’s coil.



E-liquids reach higher temperatures when dripped directly onto the coil. This also creates a bigger vapor cloud and provides a bigger throat hit. A new study now raises special concerns for teens who drip.

Allowing the liquid to get superhot can transform harmless chemicals in the e-liquid into toxic ones. (Note: At least one recent study [showed](#)

This is an atomizer used for dripping. A couple drops of e-liquids are dripped directly onto the hot coils to create a vapor cloud.

librakv/iStockphoto

<https://www.sciencenewsforstudents.org/article/e-cigs-create-toxic-vapors-harmless-e-liquids>) that the hotter the vaped liquid became, the more likely it was to undergo such a toxic transformation.) And dripping makes this super-heating likely. Some people even use attachments, called atomizers, to do this more effectively.

Vaping hobbyists that do smoke tricks may have popularized dripping, says Suchitra Krishnan-Sarin. A psychiatrist at Yale University in New Haven, Conn., she’s been studying vaping behaviors in teens. Many now drip, she and her colleagues report.

This team surveyed 1,080 Connecticut high schoolers who said they vaped. One in every four teen vapers said he or she had tried dripping.

This is the first time any study has reported on the popularity of dripping in teens. (Researchers don't yet know how common dripping is among adults.) The new statistics appear in the February *Pediatrics*.

Most teens who dripped said they had hoped it would let them make thicker vapor clouds or give the vapor a stronger taste. At present, little is known about the health risks of this type of vaping, Krishnan-Sarin notes.

And that worries her. "There's great concern," she says, "that kids are being exposed to higher levels of known carcinogens this way." Researchers don't yet know if this is true. And that's because no one has yet studied whether more of these compounds get into the body when people drip instead of vaping normally.

For now, Krishnan-Sarin says a bigger vapor cloud or more flavorful hit probably isn't worth the risk. "You don't know what you're exposing yourself to," she points out, and no one should assume that the e-liquids and the vapors they generate are harmless.

Power Words

(for more about Power Words, click [here \(https://student.societyforscience.org/power-words-aid-stem-literacy\)](https://student.societyforscience.org/power-words-aid-stem-literacy))

acetaldehyde A colorless liquid that is in the cascade of breakdown products that develops when the body metabolizes alcohol. Manufacturers use the chemical to make a range of products, including vinegar, perfume and flavorings. According to the U.S. National Toxicology Program, this chemical is also "reasonably anticipated to be a human carcinogen."

adolescent A transitional stage of physical and psychological development that begins at the onset of puberty, typically between the ages of 11 and 13, and ends with adulthood.

asthma A disease affecting the body's airways, which are the tubes through which animals breathe. Asthma obstructs these airways through swelling, the production of too much mucus or a tightening of the tubes. As a result, the body can expand to breathe in air, but loses the ability to exhale appropriately. The most common cause of asthma is an allergy. Asthma is a leading cause of hospitalization and the top chronic disease responsible for kids missing school.

behavior The way a person or other organism acts towards others, or conducts itself.

cancer Any of more than 100 different diseases, each characterized by the rapid, uncontrolled growth of abnormal cells. The development and growth of cancers, also known as malignancies, can lead to tumors, pain and death.

carcinogen A substance, compound or other agent (such as radiation) that causes cancer.

cell The smallest structural and functional unit of an organism. Typically too small to see with the naked eye, it consists of watery fluid surrounded by a membrane or wall. Animals are made of anywhere from thousands to trillions of cells, depending on their size. Some organisms, such as yeasts, molds, bacteria and some algae, are composed of only one cell.

chemical A substance formed from two or more atoms that unite (become bonded together) in a fixed proportion and structure. For example, water is a chemical made of two hydrogen atoms bonded to one oxygen atom. Its chemical symbol is H₂O. Chemical can also be an adjective that describes properties of materials that are the result of various reactions between different compounds.

chronic A condition, such as an illness (or its symptoms, including pain), that lasts for a long time.

coil Concentric rings or spirals formed by winding wire or other fiber around and around a core.

colleague Someone who works with another; a co-worker or team member.

compound (often used as a synonym for chemical) A compound is a substance formed from two or more chemical elements united in fixed proportions. For example, water is a compound made of two hydrogen atoms bonded to one oxygen atom. Its chemical symbol is H₂O.

connective tissue Certain groups of cells that attach to form the boundaries for — and interfaces between — many structures throughout the body.

dander Flakes of skin in an animal's fur or hair.

e-cigarette (short for electronic cigarette) Battery-powered device that disperses nicotine and other chemicals as tiny airborne particles that users can inhale. These devices heat up a flavored liquid until it evaporates, producing vapors. People who use these devices are known as vapers.

e-liquid A term for the solutions heated to the evaporation point in an electronic cigarette. These solutions are the basis of the vapors that will be inhaled. The liquid typically contains a solvent into which flavorings and nicotine have been dissolved.

factor Something that plays a role in a particular condition or event; a contributor.

fibroblast A type of cell found in connective tissue; it makes and releases proteins important in wound healing.

Food and Drug Administration (or FDA) A part of the U.S. Department of Health and Human Services, FDA is charged with overseeing the safety of many products. For instance, it is responsible for making sure drugs are properly labeled, safe and effective; that cosmetics and food supplements are safe and properly labeled; and that tobacco products are regulated.

formaldehyde A widely used and toxic chemical that manufacturers add to plastics, resins, some fertilizers, dyes, medicines and embalming fluids. It's even in the treatments used to keep fabrics from wrinkling.

generation A group of individuals born about the same time or that are regarded as a single group. Your parents belong to one generation of your family, for example, and your grandparents to another. Similarly, you and everyone within a few years of your age across the planet are referred to as belonging to a particular generation of humans. The term also is sometimes extended to year classes of other animals or to types of inanimate objects (such as electronics or automobiles).

germ Any one-celled microorganism, such as a bacterium, fungal species or virus particle. Some germs cause disease. Others can promote the health of higher-order organisms, including birds and mammals. The health effects of most germs, however, remain unknown.

high school A designation for grades nine through twelve in the U.S. system of compulsory public education. High-school graduates may apply to colleges for further, advanced education.

immunity The ability of an organism to resist a particular infection or poison by providing cells to remove, kill or disarm the dangerous substance.

infection A disease that can spread from one organism to another. It's usually caused by some sort of germ.

journal (in science) A publication in which scientists share their research findings with the public.

manganese Chemical element with the atomic number 25. It's a hard gray metal in the transition series. Manganese is an important component of special steels.

mitochondria (sing. mitochondrion) Structure in all cells (except bacteria and archaea) that break down nutrients and convert them into a form of energy known as ATP.

mucus A slimy substance produced in the lungs, nose, digestive system and other parts of the body to protect against infection. Mucus is made mainly of water but also includes salt and proteins such as mucins. Some animals use mucus for other purposes, such as to move across the ground or to defend themselves against predators.

nervous system The network of nerve cells and fibers that transmits signals between parts of the body.

nickel Number 28 on the periodic table of elements, this hard, silvery element resists oxidation and corrosion. That makes it a good coating for many other elements or for use in multi-metal alloys.

nicotine A colorless, oily chemical produced in tobacco and certain other plants. It creates the “buzz” associated with smoking. Highly addictive, nicotine is the substance that makes it hard for smokers to give up their use of cigarettes. The chemical is also a poison, sometimes used as a pesticide to kill insects and even some invasive snakes or frogs.

organ (in biology) Various parts of an organism that perform one or more particular functions. For instance, an ovary is an organ that makes eggs, the brain is an organ that interprets nerve signals and a plant’s roots are organs that take in nutrients and moisture.

particle A minute amount of something.

pediatrics A field of medicine that has to do with children and especially child health. A doctor who works in this field is known as a pediatrician.

persistent An adjective for something that is long-lasting.

Petri dish A shallow, circular dish used to grow bacteria or other microorganisms.

pollutant A substance that taints something — such as the air, water, our bodies or products. Some pollutants are chemicals, such as pesticides. Others may be radiation, including excess heat or light. Even weeds and other invasive species can be considered a type of biological pollution.

respiratory Of or referring to parts of the body involved in breathing (called the respiratory system). It includes the lungs, nose, sinuses, throat and other large airways.

risk The chance or mathematical likelihood that some bad thing might happen. Or the hazard — or peril — itself.

statistics The practice or science of collecting and analyzing numerical data in large quantities and interpreting their meaning. A professional who works in this field is called a statistician.

stimulant Something that triggers an action. (in medicine) Drugs that can stimulate the brain, triggering a feeling of more energy and alertness. Caffeine, for instance, is a mild stimulant that for a short while enhances alertness and helps fight drowsiness. Other stimulants, including some dangerous illegal drugs — such as cocaine — have stronger or longer-lasting effects.

tissue Made of cells, any of the distinct types of materials that make up animals, plants or fungi. Cells within a tissue work as a unit to perform a particular function in living organisms. Different organs of the human body, for instance, often are made from many different types of tissues.

tobacco A plant cultivated for its leaves, which many people burn in cigars, cigarettes, and pipes. Tobacco leaves also are sometimes chewed. The main active drug in tobacco leaves is nicotine, a powerful stimulant (and poison).

toxic Poisonous or able to harm or kill cells, tissues or whole organisms. The measure of risk posed by such a poison is its toxicity.

vaping (v. to vape) A slang term for the use of e-cigarettes because these devices emit vapor, not smoke. People who do this are referred to as vapers.

vapors Fumes released when a liquid transforms to a gas, usually as a result of heating.

variable (in mathematics) A letter used in a mathematical expression that may take on different values. (in experiments) A factor that can be changed, especially one allowed to change in a scientific experiment. For instance, when researchers measure how much insecticide it might take to kill a fly, they might change the dose or the age at which the insect is exposed. Both the dose and age would be variables in this experiment.

Readability Score:

7.6

Citation

Journal: J.F. Pankow et al. [Benzene formation in electronic cigarettes \(http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0173055\)](http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0173055).
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Further Reading

[Questions for 'Concerns explode over new health risks of vaping' \(https://www.sciencenewsforstudents.org/questions/questions-concerns-explode-over-health-risks-vaping\)](https://www.sciencenewsforstudents.org/questions/questions-concerns-explode-over-health-risks-vaping).

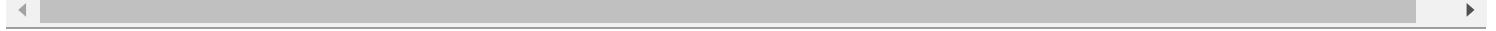
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