

Vaping while pregnant could cause craniofacial birth defects, study shows

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VCU researchers are investigating the impact vaping while pregnant could have on facial development. Credit: Virginia Commonwealth University

Using e-cigarettes during pregnancy could cause birth defects of the oral cavity and face, according to a recent Virginia Commonwealth

University study.

The findings, published in the journal *PLOS ONE* in late September, add to growing scientific evidence suggesting that e-cigarettes pose health risks despite being widely considered a safer alternative to [tobacco cigarettes](#).

Researchers in the Department of Biology in the College of Humanities and Sciences and the Department of Biomedical Engineering in the School of Engineering are the first to investigate whether e-cigarettes could be linked to the development of craniofacial birth defects, said principal investigator Amanda Dickinson, Ph.D., an associate professor in the Department of Biology. The e-cigarettes study is part of a series of projects by multiple institutions funded with a \$2 million grant from the National Institute of Dental and Craniofacial Research, part of the National Institutes of Health.

"We aim to educate the public about the dangers of vaping and compel policymakers to impose tighter regulations, such as warning labels," Dickinson said.

Building evidence

To simulate what happens to fetuses when e-cigarettes are used during pregnancy, the researchers exposed [frog embryos](#) and samples of mammalian [neural crest cells](#) to saline infused with [e-cigarette vapor](#).

Frogs, like other vertebrates, are similar to humans embryonically, Dickinson said. In both species, the same processes and genes govern major developmental events, such as [craniofacial development](#).

"This means that if a chemical perturbs a frog embryo, it's likely to do the same thing to a human embryo," she said.

Mammalian neural crest cells are also ideal models because they have a key role in embryonic facial development.

Damage to these cells in utero can cause craniofacial birth defects, said co-investigator René Olivares-Navarrete, D.D.S., Ph.D., an assistant professor in the Department of Biomedical Engineering.

"Neural crest cells are extremely important in the development of craniofacial structures because they can form many different tissues like bones, cartilage, skin, teeth and glands," Olivares-Navarrete said.

To simulate vaping, Suraj Kandalam, a [biomedical engineering](#) graduate student in Olivares-Navarrete's lab, revamped the design of a pump customized to mimic smoking tobacco cigarettes.

E-cigarettes are connected to the pump, which "inhales" the vapor. Vapor is created when e-liquids—blends of nicotine, propylene, glycol, vegetable glycerin and various flavoring compounds—are heated within e-cigarettes during inhalation. The vapor is then collected in a syringe before it is infused into saline.

Allyson Kennedy, Ph.D., a graduate of VCU's Integrative Life Sciences program, exposed the frog embryos to the saline-vapor mixture and recorded facial measurements and any incidents of [cleft palates](#) the embryos developed. Members of Olivares-Navarrete's lab tested the effects of the mixture on the viability and function of neural crest cells.

The results were surprising and strongly suggested using e-cigarettes could lead to birth defects, Dickinson said. In experimental trials for specific e-liquid types, all the frog embryos developed cleft palates.

"We observed that very complex e-liquids that mix flavors, such as berries and crème and other food-related flavorings, may have the most

dramatic effect on the face," Dickinson said.

All the frog embryos exposed to one particular e-liquid developed clefts with varying degrees of severity. The researchers have elected not to reveal the specific names of the e-liquids, or the companies that produce them, at this time. In trials with another flavor that could be described as "nutty," roughly 75 percent of the frog embryos developed clefts. When exposed to various other flavors, the frog embryos developed faces that were smaller than average, Dickinson added.

The capacity of the neural crest cells to produce associated tissues was also greatly diminished, Olivares-Navarrete said.

Researchers experimented with the same e-liquids without nicotine and found that the cells and frog embryos were still dramatically affected even when nicotine was absent.

Further studies

Olivares-Navarrete plans to publish findings on mouse models early next year. Both he and Dickinson are seeking additional funding for work that would lead to further studies.

"Next, we'll focus on explaining the mechanisms behind the cleft palates," Dickinson said. "We want to answer how the environmental stimulus of vaping affects changes in the genes that are critical for facial development."

The team wants to collaborate with a chemist to help determine exactly which chemicals in e-liquids could interact with genes in utero to cause cleft palates.

"Understanding if there is one or hundreds of molecules in [e-cigarette](#)

vapor that negatively affect craniofacial development is a difficult task because the number of commercially available e-liquids is in the thousands." Olivares-Navarrete said. "But finding these answers would give us a better understanding of the possible adverse effects of e-cigarettes."

More information: Allyson E. Kennedy et al. E-cigarette aerosol exposure can cause craniofacial defects in *Xenopus laevis* embryos and mammalian neural crest cells, *PLOS ONE* (2017). [DOI: 10.1371/journal.pone.0185729](https://doi.org/10.1371/journal.pone.0185729)

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