

# Study finds pod-based e-cigarettes with higher nicotine more likely to cause irregular heartbeat

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With the start of a new year, smokers and vapers may have resolved to quit or cut back on the habit to improve their health. They may want to use caution, however, if their strategy involves switching from cigarettes

to e-cigarettes, considered by some to be a less harmful alternative.

A new study from the University of Louisville (UofL) shows the nicotine in certain types of e-cigarettes may be more harmful than others, increasing the risk for [irregular heartbeat](#) or [heart](#) arrhythmias.

A popular claim is that nicotine in e-cigarettes is relatively harmless, whereas additives and combustion products largely account for the harms of traditional cigarettes. The UofL research, which tested the effects of e-cigarettes with various types and doses of nicotine in animal models, showed that the nicotine form contained in pod-based e-cigarettes, nicotine salts, led to [heart arrhythmias](#), particularly at [higher doses](#).

In the study published in [Nicotine and Tobacco Research](#), researchers compared heart rate and [heart rate variability](#) in mice exposed to vape aerosols containing different types of nicotine.

The aerosols contained either freebase nicotine, used in older types of e-cigarettes; nicotine salts, used in Juul and other pod-based e-cigarettes; or racemic freebase nicotine, simulating the recently popularized synthetic nicotine; and their effects were compared to nicotine-free e-cigarette aerosols or air. In addition, the research team delivered increasing concentrations of nicotine over time, from 1% to 2.5% to 5%.

The nicotine salts induced cardiac arrhythmias more potently than freebase nicotine, and the cardiac arrhythmias increased with the higher concentrations of nicotine.

"This suggests the nicotine is harmful to the heart and counters popular claims that the nicotine itself is harmless," said Alex Carll, assistant professor in UofL's Department of Physiology, who led the study. "Our findings provide new evidence that nicotine type and concentration

modify the adverse cardiovascular effects of e-cigarette aerosols, which may have important regulatory implications."

The study also revealed that the higher levels of nicotine salts increased sympathetic nervous system activity, also known as the fight-or-flight response, by stimulating the same receptor that is inhibited by beta-blockers, heart medications which are prescribed to treat cardiac arrhythmias. In the autonomic nervous system, sympathetic dominance increases the fight-or-flight response in bodily functions, including [heart rate](#).

"The nicotine in e-cigarettes causes irregular heartbeats (arrhythmias) in a dose-dependent manner by stimulating the very receptor that many heart medications are designed to inhibit," Carll said.

The findings conclude that inhalation of e-cig aerosols from nicotine-salt-containing e-liquids could increase cardiovascular risks by inducing sympathetic dominance and [cardiac arrhythmias](#).

This work is part of a growing body of research on the potential toxicity and health impacts of e-cigarettes reported by the American Heart Association Tobacco Regulation and Addiction Center, for which UofL serves as the flagship institute.

The team's [previous research](#) found that exposure to [e-cigarette](#) aerosols containing certain flavors or solvent vehicles caused ventricular arrhythmias and other conduction irregularities in the heart, even without nicotine, leading Carll to speculate that the arrhythmias may not be the result of the nicotine alone, but also by the flavors and solvents included in the e-cigarettes.

The researchers concluded that if these results are confirmed in humans, regulating nicotine salts through minimum pH standards or limits on acid

additives in e-liquids may mitigate the public health risks of vaping.

Even without regulatory changes, however, the research suggests that users may reduce potential harm by opting for e-cigarettes with freebase nicotine instead of nicotine salts or using e-cigarettes with a lower [nicotine](#) content.

**More information:** Cory Kucera et al, Nicotine Formulation Influences the Autonomic and Arrhythmogenic Effects of Electronic Cigarettes, *Nicotine and Tobacco Research* (2023). [DOI: 10.1093/ntr/ntad237](#)

Provided by University of Louisville

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