**Vaping: Is Cancer in Many Youths Future?**

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Electronic Cigarette (E-cig/vape), E-cigarette aerosol (ECA), E-Cigarette aerosols (ECAs), Acrolein, Cytotoxicity, Enhancer RNA(e-RNA), Chronic Obstructive Pulmonary Disease (COPD), Nitrosamine Ketone (NAK), Nitrosamines

**Abstract**

Proposed as a safer alternative to smoking combustible tobacco cigarettes, vaping, or usage of e-cigarettes (e-cigs), has been rapidly rising in popularity, especially among teens and young adults. E-cigs/vapes deliver the same nicotine high without the use of tobacco and its many carcinogens known to increase risks of developing certain cancers. However, this research paper aims to look at whether vapes carry these same risks through similar mechanisms or new ones. Vapes/e-cigs deliver nicotine in an aerosol state by using battery power to transform chemicals into an aerosol state when inhaled, this aerosol state allows the particles and chemicals in the vapes to lodge themselves into smaller areas of tissue and cell linings allowing it to get in and damage DNA. Multiple studies have found the chemicals in vapes to be cytotoxic, carcinogenic, or capable of DNA/RNA damage. The findings that vapes are currently taking pathways that can induce cancer is both worrisome and exciting, however, the levels at which vapes deliver these cytotoxic materials is at a much smaller amount. This leaves the question regarding if vapes deliver enough to induce cancer causing agents, or if it takes longer to go into effect?

**Introduction**

Vapes (also called e-cigarettes interchangeably) have been rising in popularity in the last decade, particularly with teenagers and young adults. Vapes are advertised as a safe alternative to cigarettes, and are thought to deliver a “safer” nicotine high without the negative carcinogenic effects found in tobacco smoke cigarettes. As the rise in usage of vapes among youth increases, so does the worry about the long-term health effects these products could be leaving, possibly even inducing certain illnesses such as cancer. This writing looks at the possibility of new cytotoxic elements and their capability of inducing cancer as well as currently known mechanisms found by tobacco smoke cigarettes. The usage of vapes continues to rise, however, there is becoming a growing amount of research into vapes and the possible health implications they could have with extended usage over time.

**Recent Progress**

Vapes act as a new source of nicotine high, without the usage of tobacco and combustible cigarettes. These devices are battery operated and heat a small container called a “pod” with liquid inside. The liquid pods hold nicotine and other chemicals that are heated instantaneously by a battery when inhaled; these chemicals are then transformed into an aerosol state. These e-cigarette aerosols (ECA, also same as vape aerosols) are tiny particles that then enter the body once inhaled and can gather in tighter areas (compared to particles inhaled via combustible smoking). Research done by Moon-shong et. al in “DNA damage, DNA repair and carcinogenicity: Tobacco smoke versus electronic cigarette aerosol” has found that E-cigarette aerosols (ECAs) are capable of hiding deeper in lung tissue. This allows for greater DNA damage. This same study also found that vapes can produce O6-methyl-deoxyguanosines (a derivative of guanine, a nitrogenous base making up DNA and RNA as well as cell signaling) in mice cells of the lungs, heart, and bladder. These are the same high-risk areas for potential cancer development due to tobacco smoke cigarettes; vapes are showing results parallel to tobacco cigarettes in harming the same tissues in mice cells. The mechanisms of cancer are known to damage in cell signaling and DNA; combustible tobacco cigarettes are known to damage DNA and possibly induce cancer; ECAs contain some of these same damaging chemicals, just at a much lower dosage. This smaller dosage, however, can add up over time. Often users do not correlate the amount of nicotine and chemicals in one pod; one JUUL pod for example is the equivalent to 20 combustible cigarettes as found in a study by Jones K, Salzman. This same study found that 63% of teens do not even know that JUUL pods or vapes contain nicotine. Some of the chemicals in vapes are found to introduce compounds such as metals or polycyclic aromatic hydrocarbons (Jones 2). These compounds have been found to be able to form DNA adducts and induce oxidative stress; these are able to lead to DNA mutations and malfunction of DNA repair mechanisms. These combinations can introduce pathways that could lead to potential cancer development. Another proposed concern in regards to vapes and potential cancer induction is the upregulation enhancer RNAs (e-RNAs). Research done by Tsai et. al found that vape usage related to the upregulation of 16 e-RNAs. The significance behind this finding is that e-RNAs are non-coding RNAs that are transcribed from enhancing regions on DNA; they help regulate many DNA functions such as transcriptional factors. The continued usage of vapes over a period of time upregulates these e-RNAs allowing extensive time for carcinogenic elements to damage DNA and introduce cancerous mechanisms. There is a new thought also that e-RNAs can be biomarkers for specific cancers. Further research into this thought could also provide further insight into the possible role they play in vaping and potential cancer induction. Research is still being done; however, current research is continually coming out with fresh and exciting studies on the potential health risks in regard to cancer that vaping may have.

**Discussion**

Interest into the topic of vaping and its potential danger of cancer induction continues to grow, as does the popularity of the product among youth. Studies have found compounds in vapes are capable of damaging DNA. This is shown in studies by Moon-shong et. al finding that vapes are capable of causing DNA repair mechanism inhibition after long term exposure, this is done via nicotine derived nitrosamine ketone (NAK). This is interesting to consider, though it raises the question to how long exposure is necessary in a lifetime in order for these negative effects to take place. A large question that has been left unanswered in relation of e-cigs and cancer induction is how much is required in order to have potential cancer-causing effects? Vapes are advertised as a safer alternative, this holds true in the lack of tobacco compared to combustible cigarettes; however, vapes still contain cytotoxic and carcinogenic materials, just in more minute amounts. Results of research currently done over the topic reveal extreme potential in the development of lung ailments, cancer is not as strongly supported as other harms to the lungs (such as lung collapse) but it is not completely ruled out. The mechanisms for introduction of multiple pathways of cancer induction exists. Once again, a large question remains of how much is needed and over what period of time? A large part of firm holding evidence of vaping and potential cancer development is just time, waiting to see the results of foreign chemicals in the body over extended periods of time. Another interesting thought that is important to mention is the battery operation of vapes. The aerosols being heated by the vape are done so via a battery. The chemicals of a vape and its pod are not the only carcinogenic elements to a vape, but batteries contain carcinogenic elements such as nickel. The results of the study done by Moon-shong et. al hold fairly valid, they address the findings in mice but also some in connection to human cell linings tested in lab. Their results show evidence across species and show results similar to those that were first found in testing tobacco cigarettes. The research done by Tsai et. al is valid in that it tested the upregulation of e-RNA of humans and their relation to the chemicals in vapes. The results from this research gives one of the most direct findings in relation to vape chemicals having access to RNA or DNA mechanisms and that they can therefore hold the ability to tamper with these mechanisms. As research continues to grow over such an interesting and new topic, again the main question remains; how much and how long do these vapes take to potentially harm their growing fanbase of youthful users?

**References**

Jones K, Salzman GA. The Vaping Epidemic in Adolescents. *Mo Med*. 2020;117(1):56-58.

Moon-shong Tang, Hyun-Wook Lee, Mao-wen Weng, Hsiang-Tsui Wang, Yu Hu, Lung-Chi Chen, Sung-Hyun Park, Huei-wei Chan, Jiheng Xu, Xue-Ru Wu, He Wang, Rui Yang, Karen Galdane, Kathryn Jackson, Annie Chu, Elizabeth Halzack, “DNA damage, DNA repair and carcinogenicity: Tobacco smoke versus electronic cigarette aerosol, Mutation Research/Reviews in Mutation Research, Vol. 789, 2022,108409.

Tsai, Joseph C., Omar A. Saad, Shruti Magesh, Jingyue Xu, Abby C. Lee, Wei T. Li, Jaideep Chakladar, Mark M. Fuster, Eric Y. Chang, Jessica Wang-Rodriguez, and Weg M. Ongkeko. 2021. "Tobacco Smoke and Electronic Cigarette Vapor Alter Enhancer RNA Expression That Can Regulate the Pathogenesis of Lung Squamous Cell Carcinoma" *Cancers* 13, no. 16: 4225(2021).