Smoking leaves 30-year legacy on your DNA

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Story highlights

Tobacco smoke leaves its mark on DNA by changing its chemical surface

Changes could be used to predict risk of smoking-related diseases, experts hope

(CNN) — Smokers have a "footprint" of their addiction on their genes that could be used to identify, and develop treatments for, smoking-related diseases such as cardiovascular disease and cancer, according to a new study published Tuesday.

An analysis of almost 16,000 blood samples from smokers, former smokers and nonsmokers found that tobacco smoke leaves a lasting legacy of people's addiction on the surface of their DNA.

Some changes were still seen in participants who had kicked the habit 30 years ago.

Genetic legacy

This legacy occurs in the form of chemical changes to the surface of DNA that, in turn, affect how particular genes function, known as epigenetic changes. The modification identified in this study was DNA methylation, in which a molecule called a methyl group sits on the surface of DNA and influences whether genes are active or silent.

Studies have showed that smoking can cause these surface changes to DNA and that these changes could be used to measure the risk of particular diseases, such as cancer. But the new study, published in the journal Circulation: Cardiovascular Genetics, identified the diversity of the affected genes, the strength of the association with smoking and what genes are involved in someone's risk of disease.

"We had a very large sample, which gave us a lot of power ... and found sites in thee where smoking leads to a difference in methylation," said Dr. Stephanie London, deputy chief of the epidemiology branch of the National Institute of Environmental Health Sciences, who led the study. "The genes we found to be impacted were ones associated with smoking-related diseases," she said.

Analyzing the genome

To determine the difference in gene changes between smokers and nonsmokers, the researchers analyzed 15,907 blood samples from 16 groups of participants and searched across their genomes for sites that had these methyl groups attached.

The team found more than 2,600 sites that were statistically different between smokers and nonsmokers. These mapped to more than 7,000 genes, equaling one-third of known human genes.

"There were a large number of methylation signals" in smokers, London said.

Among people who had quit smoking, within five years, the majority of these sites had returned to levels similar to those in people who had never smoked. However, some of the surface gene changes even persisted 30 years after quitting.

When comparing former smokers with nonsmokers, 185 of the more than 2,600 sites identified as different in smokers continued to harbor these chemical changes.

"Our study has found compelling evidence that smoking has a long-lasting impact on our molecular machinery, an impact that can last more than 30 years," said Dr. Roby Joehanes of the Institute for Aging Research, a co-author of the study. "The encouraging news is that once you stop smoking, the majority of DNA methylation signals return to never-smoker levels after five years, which means your body is trying to heal itself of the harmful impacts of tobacco smoking."

Preventing disease

Smoking is the leading cause of preventable death worldwide. Despite a decline in recent decades, almost 17% of US adults over the age of 18 reported that they smoked in 2014 -- equating to 40 million adults.

Globally, more than 1.1 billion people smoked tobacco in 2015, with 80% of them living in low- and middle-income countries, according to the World Health Organization. Once someone quits, they remain at risk of developing some cancers, obstructive pulmonary disease and stroke.

The team believes their new insight means DNA could be used to reveal a person's smoking history in detail, to better inform studies that explore risk factors for diseases like heart disease and lung cancer. "These would be useful to identify the effects of smoking in (other) studies," said London.

Understanding these gene changes also provides opportunity to develop -- and target -- new therapies.

"We identified many genes affected by smoking," London said, adding that new therapies could target these genes to prevent smoking-related diseases. "(If) we understand what smoking does, we can potentially intervene."

"The study showed that several of the observed smoking-associated DNA methylation alterations are in genes involved in pulmonary function, hypertension and in diseases such as cardiovascular diseases, chronic obstructive pulmonary disease and lung cancer, all conditions known to be affected by cigarette smoking," said Dr. Gianluca Severi, director of the Human Genetics Foundation, who was not involved in the study. "(By) developing a new and more accurate tool to determine past exposure to cigarette smoking, (we can) improve prediction of its effect on health."

Some experts hope the findings will remind people of how harmful smoking can be.

"This large and well-performed study ... (shows) that while many of these changes are reversible, some are very long-lasting and may affect risk of future disease even though the person has stopped smoking," said Jeremy Pearson, associate medical director at the British Heart Foundation.

"It further emphasizes the point that while giving up smoking is a very important way to reduce risk of serious disease, it is even better to not start at all," he said.