

Air pollution may spur irregular heart rhythms in healthy teens

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Breathing particulate matter (i.e., tiny particles suspended in the air) air pollution may trigger irregular heart rhythms (arrhythmias) in healthy teenagers, according to new research published today in the *Journal of*

the American Heart Association.

While the negative cardiovascular effects of [air pollution](#) on adults has already been established, this study is the first to assess the impact of air pollution on teenagers in the general population.

"While relatively rare, irregular [heart](#) rhythms can lead to sudden cardiac death in otherwise healthy adolescents and [young adults](#). Our findings linking air pollution to irregular heart rhythms suggest that particulate matter may contribute to the risk of sudden cardiac death among youth," said Fan He, Ph.D., lead author of the study and an instructor in public health sciences at the Penn State College of Medicine in Hershey, Pennsylvania. "Since childhood and adolescent cardiovascular conditions can track into adulthood and affect risk of major cardiovascular disease later in life, identifying modifiable risk factors of cardiac arrhythmia that may cause sudden cardiac death among adolescents should be of great public interest."

The study examined the impact of breathing [fine particulate matter](#) on heart rhythms of adolescents. Fine particulates (PM_{2.5}) are less than 2.5 microns in size and can easily be inhaled deep into the lungs and even enter the bloodstream. Particles smaller than 2.5 microns are usually related to fuel combustion, such as particles from car exhaust or wildfires. Once inhaled, the pollutants irritate the lungs and blood vessels around the heart, and previous research has suggested that over time, pollutants increase the process of disease in the arteries.

The investigators analyzed the impact of breathing particulate matter pollution on two types of irregular heart rhythms characterized by premature contraction in the heart muscle, often described as a "skipped heart beat." In premature atrial contractions (PAC), the heartbeat originates from the atria (top chambers of the heart). This usually causes no symptoms or harm, however, frequent, premature atrial contractions

have been related to an increased risk of atrial fibrillation—a severe form of arrhythmia in which the top chambers quiver instead of beating effectively, thereby raising the risk of blood clots and stroke. Premature ventricular contractions (PVC) occur when the heartbeat originates from one of the ventricles (lower chambers of the heart). These also raise the risk of later heart attack, stroke, heart failure or sudden cardiac death.

If premature contractions cause no symptoms, they are not treated. However, if they occur often and lead to frequently feeling a skipped heartbeat, fast heartbeat or a pounding heart, treatment with medications, implantable devices or procedures may be advised.

Researchers analyzed health data for 322 adolescents (average age 17 years; 56% males; 79% non-Hispanic white teens) living in central Pennsylvania who participated in a follow-up evaluation in the Penn State Child Cohort study. That study, conducted between 2002 and 2006, initially recruited children ages 6 to 12 years. The data analyzed in this study reviewed results from the follow-up evaluation nearly 7.5 years later (2010-2013). This group of children were free of major cardiovascular conditions and considered at low risk for irregular heart rhythms. In the follow-up study, the researchers simultaneously measured exposure to fine particulate matter in the air each teen breathed (using a device called a nephelometer) for 24 hours and EKG tracings of each teen's heart rhythms via a small wearable device called a Holter monitor.

The average $PM_{2.5}$ concentration measured in the study was approximately 17 micrograms of particulate matter per cubic meter of air ($\mu\text{g}/\text{m}^3$) per day, which is well-below the health-based air quality standard of $35 \mu\text{g}/\text{m}^3$ established by the U.S. Environmental Protection Agency (EPA).

The study found:

- 79% of the participants had at least one irregular heart rhythm during the 24-hour study period. Of that group, 40% had only premature atrial contractions, 12% had only premature ventricular contractions, and 48% had both.
- A 5% increase in the number of premature ventricular contractions within two hours of exposure was noted for each increase of 10 $\mu\text{g}/\text{m}^3$ in $\text{PM}_{2.5}$.
- No association was found between the concentration of particulate matter and the number of premature atrial contractions.

"It is alarming that we were able to observe such a significant impact of air pollution on cardiac arrhythmias when the air quality remained well within the health-based standards established by the EPA. It may suggest that adolescents who live in highly polluted areas such as inner cities are at even higher risk," He said.

The results were consistent with data previously obtained in adults using similar methods from these researchers and others, although the increase in premature ventricular contractions was even higher in adults.

Reducing the risk of [irregular heart rhythms](#) in adolescents may reduce their risk of developing heart disease as adults, according to the study authors.

"Our study found that air pollution increases the risk of cardiovascular diseases and [sudden cardiac death](#), even among healthy adolescents," He said. "Protective measures, such as wearing masks and avoiding vigorous physical activities, may be warranted on days that [particulate matter](#) concentration is high, especially during early morning rush hours."

The most effective way to reduce everyone's exposure to air pollution is by supporting more robust national-level air quality regulations, said

American Heart Association volunteer expert Robert D. Brook, M.D., FAHA, professor of medicine at Wayne State University in Detroit. Brook has co-authored several American Heart Association scientific statements on air pollution.

"PM_{2.5} levels have fallen dramatically since the 1970s-80s due to regulations that have been unquestionably linked to improved health effects and life expectancy," Brook said. "We outlined in a recent AHA scientific statement, titled [Personal-Level Protective Actions Against Particulate Matter Air Pollution Exposure](#), strategies and activity or behavioral changes that may reduce pollution exposure, such as portable air cleaners, facemasks, respirators and exercising during non-peak hours. However, there have been no studies to show these measures can actually prevent adverse clinical health effects such as heart attacks."

According to a [2020 American Heart Association policy statement](#) citing a [global study](#), ambient air pollution is widely recognized as a significant contributor to cardiovascular disease and death. In 2017, exposure to particulate air pollution was estimated to be associated with more than 7 million premature deaths and the loss of 147 million healthy life-years globally. The Association recommends further development of evidence-based policy approaches, continued investment in research and greater innovation and transformational partnerships to reduce the cardiovascular burden of ambient air pollutants in the U.S.

"The most interesting and significant aspect of this study is clearly that the results were found in healthy young adolescents," Brook said. "The study adds support for the concern that even healthy young people are not immune to adverse cardiovascular responses to PM_{2.5} and at exposure levels within National Ambient Air Quality Standards for 24 hours established by the EPA. It is plausible that the findings help explain the potential reason for the time of onset of arrhythmias and even sudden death in some susceptible young people."

Dr. He and colleagues are currently evaluating the impact of air pollution on other markers of cardiac electrical activity.

This study was limited in not being able to analyze the impact of air pollution on different subtypes of premature ventricular contractions, which may help cardiologists better understand how [pollution](#) impacts heart function. Results from this study in adolescents may not be generalizable to younger children.

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