Noise Could Take Years Off Your Life. Here's How.

We used a professional sound meter to measure the din of daily life and talked to scientists about the health risks it can pose.

June 9, 2023

Bankers Hill, San Diego

On a spring afternoon in Bankers Hill, San Diego, the soundscape is serene: Sea breeze rustles through the trees, and neighbors chat pleasantly across driveways.

Except for about every three minutes, when a jet blazes overhead with an ear-piercing roar.

A growing body of research shows that this kind of chronic noise — which rattles the neighborhood over 280 times a day, more than 105,000 each year — is not just annoying. It is a largely unrecognized health threat that is increasing the risk of hypertension, stroke and heart attacks worldwide, including for more than 100 million Americans.

We've all been told to limit the volume on our headphones to protect our hearing. But it is the relentless din of daily

life in some places that can have lasting effects throughout the body.

Anyone who lives in a noisy environment, like the neighborhoods near this Brooklyn highway, may feel they have adapted to the cacophony. But data shows the opposite: Prior noise exposure primes the body to overreact, amplifying the negative effects.

Even people who live in relatively peaceful rural and suburban communities can be at risk. The sudden blare of trains that run periodically through D'Lo, Miss. (population: less than 400), can be especially jarring to the body because there is little ambient noise to drown out the jolt.

We went to neighborhoods in rural Mississippi, New York City, and suburban California and New Jersey to measure residents' noise exposure and interview them about the commotion in their lives. We consulted more than 30 scientists and reviewed thousands of pages of research and policy to examine the pathology and epidemiology of noise.

What noise does to your body

A siren shrills. A dog barks. Engines thrum. Jackhammers clack.

To understand this pathway, researchers broke it down: They scanned the brains of people as they listened to unpleasant sounds — styrofoam rubbing, nails on a chalkboard, a dentist's drill — and watched live as their amygdalas activated. They also strapped blood pressure monitors and noise dosimeters onto auto assembly plant workers during a shift to see their blood pressures and heart rates rise with their noise exposure.

To simulate relentless nights, scientists played dozens of sporadic recordings of passing trains and planes overhead in healthy volunteers' bedrooms — recordings taken of real disruptions from people's homes. They found that the next morning, the volunteers had higher adrenaline levels, stiffened arteries, and spikes in plasma proteins that indicate inflammation.

When researchers analyzed the brain scans and health records of hundreds of people at Massachusetts General Hospital, they made a stunning discovery: Those who lived in areas with high levels of transportation noise were more likely to have highly activated amygdalas, arterial inflammation and — within five years — major cardiac events.

The associations remained even after researchers adjusted for other environmental and behavioral factors that could contribute to poor cardiac health, like air pollution, socioeconomic factors, and smoking.

In fact, noise may trigger immediate heart attacks: Higher levels of aircraft noise exposure in the two hours preceding nighttime deaths have been tied to heart-related mortality.

How loud is too loud?

Sound is often measured on a scale of decibels, or dB, in which near total silence is zero dB and a firecracker exploding within a meter of the listener is about 140 dB.

We used a professional device called a sound level meter to record the decibel levels of common sounds and environments.

That's because the decibel scale is logarithmic, not linear: With every 10 dB increase, the sense of loudness to the ear generally doubles. And that means regular exposure to even a few more decibels of noise above moderate levels can trigger reactions that are harmful to health.

According to the World Health Organization, average road traffic noise above 53 dB or average aircraft noise exposure above about 45 dB are associated with adverse health effects.

Nearly a third of the U.S. population lives in areas exposed to noise levels of at least 45 dB, according to a preliminary analysis based on models of road, rail and aircraft noise in 2020 from the Department of Transportation.

This chart shows how many people in the United States may be exposed to various outdoor noise levels, on average. Since transportation patterns in 2020 were low because of the pandemic, researchers suspect that current transportation-related noise could be notably higher.

3 million people in the U.S. may live in areas with average outside noise levels above 70 dB

60-70 dB 9 million

50-60 dB

39 million

45-50 dB

44 million

<45 dB

232 million

In this Brooklyn apartment, the windows are closed, but indoor sound levels are consistently above the maximum average levels recommended by the W.H.O.

Brooklyn-Queens Expressway

The nighttime noise that a person in such an environment experiences is considered particularly detrimental to health because it can fragment sleep and trigger a stress response, even if the person does not recall being roused.

The W.H.O. has long recommended less than 40 dB as an annual average of nighttime noise outside bedrooms to prevent negative health effects, and less than 30 dB of

nighttime noise inside bedrooms for high-quality sleep. That's even quieter than inside this house in D'Lo, when a train isn't going by.

D'Lo, Miss., in between trains.

Mounting research suggests that the relationship between noise levels and disease is eerily consistent: A study following more than four million people for more than a decade, for example, found that, starting at just 35 dB, the risk of dying from cardiovascular disease increased by 2.9 percent for every 10 dB increase in exposure to road traffic noise.

The increase in risk of dying from a heart attack was even more pronounced: Also starting at just 35 dB, it increased by 4.3 percent for every 10 dB increase in road traffic noise.

Not all loud noise is equal

At High Tech Middle School in Point Loma, San Diego — less than a mile from the runway of San Diego International Airport — the roofs above classrooms are heavily insulated to mitigate the rumble. But students still have a term for an aircraft interruption so loud that it halts discussion: the Point Loma Pause.

Scientists believe that pronounced fluctuations in noise levels like this might compound the effects on the body. They suspect jarring sounds that break through the

ambience — recurring jet engines, a pulsating leaf blower, or the brassy whistle of trains — are more detrimental to health than the continuous whirring of a busy roadway, even if the average decibel levels are comparable.

To visualize the concept, Swiss researchers measured and compared transportation noise along a highway with a railroad track, over the course of a night.

In a subsequent Swiss study, higher degrees of nighttime "noise intermittency" — or the extent to which sound events were distinguishable from the background levels — were associated with heart disease, heart attacks, heart failure and strokes.

Who is most at risk?

As with so many health issues, poor people and communities of color are more likely to experience excessive noise exposure because they often have fewer housing choices and are more likely to live near high-traffic roads, raucous waste dumps and industrial areas.

According to a study of more than 94,000 schools, students in those estimated to be most highly exposed to road or aviation noise were significantly more likely to be eligible for free or reduced-price meals and to be Hispanic, Black, or Asian/Pacific Islander. Such excess noise in schools is associated with heightened stress hormones, lower reading scores and even hyperactivity

among children.

Nighttime noise shows similar inequities. Census data shows that city communities with almost no low-income residents averaged 44 dB at night, compared with about 47 dB in those where half of residents fall below the poverty line. Neighborhoods with almost no Black residents averaged about 42 dB at night, compared with about 46 dB in communities that were three-fourths Black.

The difference of a few dBs might not seem like much, but for every one dB increase, the risk of developing cardiovascular disease climbs by roughly another percentage point, according to a preliminary analysis of more than 100,000 U.S. nurses. And as dBs climb, so too do associations with death because of cardiovascular disease and heart attack.

The disparities in noise exposure are likely to be much larger than the noise model suggests, researchers said, since wealthier households and schools are more likely to install triple-pane windows and more insulation. And the inequities are not unique to the United States: Spatial modeling has revealed similar disparities within various countries across four other continents.

What can be done?

Fifty years ago, under the Noise Control Act of 1972, the

newly formed Environmental Protection Agency was a trailblazer in recognizing the danger of noise and addressing it: It educated the public, established safety limits, published deep analyses on various culprits and recommended actions to mitigate harm.

But its office of noise abatement was defunded by the Reagan administration, rendering policies unenforceable and regulatory criteria obsolete. The Occupational Safety and Health Administration's eight-hour workplace noise limit is still 90 dB.

European countries have far outpaced the rest of the world in regulating noise. The European Union requires member nations to monitor and assess sound levels across regions and to produce new action plans every five years to address communities at greatest risk. The E.U. now mandates quiet brake locks on rail freight fleets and noise labels on outdoor power equipment; it also requires noise reduction in car manufacturing and mitigation efforts at airports.

Individual cities and countries have taken additional measures. Paris has installed noise cameras that measure the sound level of vehicles and fine drivers who exceed them. Berlin has used new bike lanes to reduce the flow of engine-powered vehicles and move the source of the noise to the center of the road, away from houses. Switzerland has introduced national "quiet hours" — overnight, one midday hour on weekdays, and all day on

Sundays.

While scientists say it's too soon to make a prediction about the effects of these policies on cardiovascular health, several European countries have reported tens of thousands fewer residents exposed to major sources of noise.

Like many health issues, protection against noise would be economically advantageous. Economists who analyzed health care spending and productivity loss because of heart disease and hypertension have argued that a 5 dB reduction in U.S. noise could result in an annual benefit of $3.9 billion.

But unlike most other contributors to heart disease, noise cannot be addressed fully between a patient and a doctor. Protection requires changes in local, state and federal policy.

In the meantime, in D'Lo, Miss., George Jackson has repeatedly jacked his home to decrease the vibration. In Mendenhall, Carolyn Fletcher tried resealing her windows. In Bankers Hill, Ron Allen says all he can do is take vitamin supplements and plug his ears.

Sources and methodology

For the decibel graphic on the videos and the graphic comparing decibel levels, we measured decibels using a SoundAdvisor Model 831C sound level meter from Larson

Davis. In both cases, we show A-weighted decibels to emphasize the frequencies that are available to the human ear and that are commonly used in health studies and regulatory requirements. For each video, we positioned the sound level meter next to the camera, which was about shoulder height.

For the decibel graphic, we measured sound levels in an empty room; on the sidewalk of a busy New York City street; and a few inches away from a hair dryer in a quiet room. The videos show decibel changes on a linear scale.

Most research and policy cited in this article used A-weighted measurements.

Estimates of the number of people in the United States exposed to each decibel range do not include U.S. territories and are from Department of Transportation data analyzed by Edmund Seto and Ching-Hsuan Huang at the University of Washington.

The data for the Swiss transportation noise chart was provided by Jean Marc Wunderli at the Swiss Federal Laboratories for Materials Science and Technology, and it was derived from research in the Journal of Exposure Science and Environmental Epidemiology.

Anatomy references are from the third edition of "Anatomische Atlas," edited by Anne M. Gilroy, Brian R. MacPherson and Jamie C. Wikenheiser.

Additional sources

Jamie Banks, president of Quiet Communities and chair of the Noise & Health Committee at the American Public Health Association

Dr. Mathias Basner, sleep and health researcher, University of Pennsylvania

Stuart Batterman, professor of environmental health sciences, University of Michigan

Rachel Buxton, soundscape ecologist, Carleton University

Joan Casey, assistant professor, University of Washington School of Public Health

Timothy William Collins, professor of geography, University of Utah

Andreas Daiber, molecular cardiologist, University Medical Center Mainz

Gary Evans, environmental and developmental psychologist, Cornell University

Dr. Daniel Fink, board chair, The Quiet Coalition

Kurt Fristrup, affiliate research scientist at Colorado State University, retired sound researcher at the National Park Service

Ching-Hsuan Huang, doctoral candidate, University of Washington

Chandra Jackson, cardiovascular epidemiologist and investigator, National Institutes of Health

Peter James, environmental epidemiologist, Harvard Medical School

Chucri Kardous, retired research engineer, National Institute for Occupational Safety and Health

Nina Lee, doctoral student and research assistant at the Brown Community Noise Lab

Dr. Thomas Münzel, chief of cardiology, University Medical Center Mainz

Dr. Jose V. Pardo, professor of psychiatry, University of Minnesota

Dr. Andrei Pyko, environmental epidemiologist, Karolinska Institutet

Rebecca Rolland, speech-language pathologist and Harvard lecturer

Charlie Roscoe, postdoctoral fellow, Harvard University

Edmund Seto, associate professor of Environmental and Occupational Health Sciences, University of Washington

Ed Strocko, director of the Office of Spatial Analysis and Visualization, Bureau of Transportation Statistics

Dr. Ahmed Tawakol, associate professor of medicine, Harvard Medical School

Danielle Vienneau, group leader, Swiss Tropical and Public Health Institute

Erica Walker, assistant professor of epidemiology, Brown University School of Public Health

Jean Marc Wunderli, chair of the acoustics and noise control lab, Swiss Federal Laboratories for Materials Science and Technology

Special thanks to community members in D'Lo, Mendenhall and Braxton, Miss.; Loma Portal, Ocean Beach and Bankers Hill in San Diego, Calif.; South Orange, N.J.; and Greenpoint, Brooklyn.