

Low-frequency Noise Is Pervasive. Does That Matter?

Sounds that are lower pitched are less studied than other types. Some say it's a health hazard. Others have doubts.

Visual: Moment via Getty Images

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OR TWO YEARS, Erica Walker routinely wore ear plugs to dampen the sound of stomping footsteps penetrating her basement apartment ceiling. Still, the noise from her upstairs neighbors, undetected by sound level meters, rumbled in her chest day and night.

“The funny thing about it was that the noise wasn’t loud,” she said. But it bothered her, this unwelcome sensation she couldn’t control.

The pleasant and unpalatable sounds that envelop daily life travel through the air in different frequencies perceived as pitch. In bustling cities, the

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Low-frequency, or low-pitched noise, like what Walker experienced, is among the most elusive: Traditional measurement tools don't capture it well, and it's mostly absent from official consideration outside occupational contexts. Unlike high-frequency sounds, low frequency waves can penetrate walls more easily and carry farther distances, which is why a neighbor might only hear the heavy bass from a party down the street.

Erica Walker, assistant professor of epidemiology at Brown University and founder of the school's Community Noise Lab, started to research noise after the sound of her upstairs neighbors' footsteps forced her to use ear plugs and increased her stress.

Visual: Courtesy of Erica Walker

But even sounds that aren't audible to everyone have inspired complaints of headaches, anxiety, heart palpitations, and sleep troubles. And some question whether such symptoms are physiological or psychological. One thing is clear: Low-frequency noise is less studied and less understood than other sounds. And exactly what effects it may — or may not — have on humans is far from settled.

“We're not at the point yet where we can make causal inferences about how it's impacted our health,” said Walker, whose experience with her neighbors— which she said contributed to stress, increased blood pressure, and stomach problems — helped inspire her to research noise noise as an assistant professor

scientists need to learn how to measure it and “look at its associations with individual and community health.”

Most cities and towns have ordinances that regulate noise under nuisance standards focusing on time-of-day violations, such as the blasting music from a neighbor’s late-night party. In instances when noise is measured, a challenge lies with the most common standard used, which fails to fully capture the low-frequency noise that the World Health Organization has identified as an environmental problem.

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In fact, much of the noise that people encounter in their everyday world is concentrated in the lower pitched frequencies, said René Gifford, a professor of hearing and speech sciences at the Vanderbilt School of Medicine in Nashville, Tennessee. If lower frequency noise is negatively affecting a critical mass of people, said Walker, then it is worth deciphering

Meanwhile, “by definition, noise is called unwanted sound,” Walker said. “And so that unwanted definition in sound is very much subjective.” While low-frequency noise may bother some people, the same sound can lull others to sleep.

“It just depends on the individual,” she said. “But I know that there are communities that are inundated with low-frequency sound, and it’s something that we as a country haven’t really grappled with yet.”

SOUND RIPPLES from its source like a wave, and its effect depends on various factors: frequency, duration, the environment in which the sound is heard, and the human ear’s subjective perception of its intensity.

Frequency refers to how many times that wave of sound repeats itself over a particular time, and it “gives you the character of the sound that is a little bit different than how loud it is,” Walker said. “So low frequency and high frequency noises can be very loud or they can be very quiet.” (Decibels, meanwhile, measure loudness; most city noise ordinances are based on decibels.)

Low-frequency noise is typically perceived as a low-throbbing or deep rumble. When a freight train moves, for example, it produces vibrations that travel through the ground moving long distances

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until they are perceived as both a shaking sensation and low pitch. And then there is infrasound, which is usually set below the human hearing threshold.

In those lower frequencies, the normal variations in human hearing mean that this type of noise can be perceived as vibrations. “The vibratory effects can still impact various physiologic systems within our body,” Gifford said. “It’s just that we’re not processing them through our hearing mechanism.”

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The deep rumbling sound of thunder from a distant lightning bolt, for example, can cause vibrations in the chest and throughout the body as the frequency changes from high to low while traveling. “That would be a combination of the feeling that you feel, and you also have the auditory stimulation,” she said.

Infrasound generally doesn’t even audibly register. For example, some of the sound produced by natural events, such as earthquakes, avalanches, and tsunamis, along with human inventions such as distant aircraft and machinery, can be below the

“Prior to an earthquake, there tends to be infrasound that some research has shown some people can actually feel it or start feeling a little strange, off balance, maybe even nauseated,” Gifford said.

David Woolworth, an acoustic engineer in Oxford, Mississippi, hears a lot of complaints about booming music, often emitting from cars (<https://undark.org/2017/12/27/highway-noise-barrier-science/>). The advent of inexpensive, low-frequency amplification has changed the sound of music that spills into the environment since The Beatles first performed in 1960s New York, Woolworth said. “They had a tiny little system,” he said of the legendary English rock band. “The people were louder than the band.” Since then, “low frequency amplification became much more efficient, and the amplifiers became lighter and smaller. And now you can have cars driving around that shake a whole neighborhood.”

And while barriers can filter out middle and higher frequencies, those in the lower ranges in general have “thresholds at which windows, walls, and floor ceiling assemblies start to vibrate,” he said.

Meanwhile, the standard way to measure for environmental noise is through a system known as the A-weighted decibel metric, which de-emphasizes low frequencies over higher frequencies, making it harder to measure. Other variables also can interfere in the lower frequencies, both audible and inaudible. “The sound waves propagate further, penetrate building envelopes more easily, and other factors such as topography, wind, location and the sensor you are using can come into play,” Woolworth said.

Various studies, some using animals as subjects, suggest a link between frequencies at the lower end of the spectrum and a negative impact on health. But many of those studies include a limited number of participants. And after many years, much of the research on how and to what extent harm can occur continues. “It’s just that the magnitude of the effects is quite varied across studies,” Gifford said.

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RESEARCH ON THE health impact of noise, mostly focused on occupational exposure, dates to the early 20th century. But it wasn’t until the 1970s and 1980s that scientists trained their collective lens on the

on its impact on quality of sleep. Later research focused exclusively on low-frequency noise have linked it to discomfort, stress, sleep disorders, high blood pressure, and cardiovascular diseases.

In one of Walker's early experiments (<https://ncbi.nlm.nih.gov/pmc/articles/PMC5003641/>), for example, ten healthy men were exposed to short-term, low-frequency and high-frequency noise in an acoustics laboratory and then had their acute cardiovascular and stress responses measured. The results showed decreases in heart rate variability, the variation in time intervals between beats, with exposure to low-frequency noise, in particular. A lowered heart rate variability is associated with the body's reduced ability to cope with stress.

One of the most notorious sources of low-frequency noise that stirs health-related complaints are electricity-generating wind farms

(<https://www.popsci.com/environment/wind-turbines-effects-health/>). Researchers have investigated whether exposure to the giant, three-pronged turbine blades rotating contributes to sleep disturbances, dizziness, high blood pressure, and chronic health conditions such as heart disease. And

even though wind farms and their potential connection to health harm are among the most studied in the field, results are inconclusive.

Wind turbines produce a combination of some audible noise and infrasound that some people may be more sensitive to than others, Gifford said.

“That’s probably why — and again, this is speculation because we just don’t know why — some people are experiencing issues and reported problems and others don’t,” she said.

Indeed, some studies point to an association between wind turbine noise that puts people who live nearby at higher risk for ill health, like insomnia and nausea. One couple in France even sued for — and won — more than 100,000 euros for symptoms they said were caused by living near a windfarm. But such claims are contentious

(<https://www.theatlantic.com/science/archive/2017/06/wind-turbine-syndrome/530694/>), and other research (<https://theconversation.com/why-a-dedicated-research-fund-for-wind-farms-and-health-37469>) suggests that there is no connection.

Robert McCunney, a physician and environmental health expert in Boston, is among those who have concluded that the evidence doesn't support claims that the low-frequency noise component of wind farms cause direct health effects. He is the main author of a 2014 review (<https://pubmed.ncbi.nlm.nih.gov/25376420/>) of scientific literature on wind turbines and health that found low-frequency noise was more related to annoyance than unique health risks. "As far as I'm aware, the conclusions we drew in that paper are applicable today," said McCunney, who teaches at Harvard Medical School.

McCunney's findings were echoed in another study (<https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html>) that the Canadian government published in 2014 on the safety of wind farms. The research, which involved residents living in more than 1,000 dwellings near turbines, found that noise exposure annoyed people but was not associated with sleep disruption, stress, and self-reported health effects.

Gas-powered leaf blowers — which operate at a lower frequency than their electrical counterparts

that their use is being restricted or outright banned.

In a 2017 analysis

(<https://pubmed.ncbi.nlm.nih.gov/31448365/>) of leaf blowers, Walker found that the noise the lawn equipment produces can persist at high intensity levels up to 800 feet away.

“The thing about low-frequency noise is that it travels very long distances, it’s hard to abate, and it can penetrate through walls and structures,” she said. “So not only is it ubiquitous, it is insidious.”

However, controversy persists over the sources of low-frequency sounds and whether they actually harm health. A 2022 review

(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9999102>) of the literature found that some people who are chronically exposed to low-frequency noise can develop significant health conditions. Research on chronic exposure, including in aircraft technicians, has found effects such as changes in the inner ear, depression, mental health disfunction, cellular and tissue damage, and numerous health complications

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In other studies, exposure to low-frequency noise from different sources has shown some effects on the health of both animals and humans. In a 2017 study, researchers put nearly 100 rats into chambers where some were exposed to short sessions of low-frequency sound for 13 weeks below 250 hertz and sound pressure levels of up to 150 decibels. Its findings

(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5437756/>) suggested that low frequency noise “may have possible mutagenic effects and cause massive cell death.”

Meanwhile, a 2014 study (<https://doi.org/10.1098/rsos.140166>) involving humans exposed 21 volunteers with normal hearing to 90 seconds of deep, vibrating sound of about 30 hertz in a sound booth. Afterward, fluctuations that recordings captured from the faint sounds flowing from their healthy ears — known as otoacoustic emissions — suggested that the very low frequency sound could be damaging, but reversible, in the short term. It did not show evidence of permanent damage.

A more recent systematic review (<https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12023-17593-5>) of studies published in January explored low frequency noise exposure and

frequency noise affected memory or attention levels. However, the findings suggested that it may reduce “higher-order cognitive functions” such as logical reasoning and mathematical calculations.

Despite the lack of scientific consensus, complaints about low-frequency noises persist. And the most contested of such sounds might be what’s known commonly as the “Worldwide Hum”: For decades, people from North America to Europe and Australia have heard a mysterious, low-pitched noise they describe as a hum, low rumble, or vibration that can annoy them, keep them up at night or induce ill feelings.

In Taos

(<https://www.discoveryuk.com/mysteries/the-taos-hum-new-mexicos-unexplained-acoustic-phenomenon/>), New Mexico, low-frequency noise has frustrated a small part of the population for years. Theories about the origin of the hum range from industrial equipment to seismic activity and

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(<https://www.brummton.info/wp-content/uploads/2023/06/PDF-Dokument-Franz-G.Frosch-2022-Tinnitus-Journal-.pdf>) that builds on previous research linked the hum to tinnitus, a condition that fills the ears with ringing, roaring, or buzzing sounds heard only by the sufferer.

Glen MacPherson, a high school science teacher who said he first heard the hum in the spring of 2012 while living in the British Columbia coast of Canada, doesn't buy the study's findings. "I've got a big problem with that," he said.

MacPherson, who was the only member of his family to hear the hum, created the World Hum Map and Database Project (<https://www.thehum.info/>) to document the phenomenon. He has tracked numerous reports from people who are able to hear it — an estimated 2 to 4 percent of the world population. Among them are those with tinnitus who also hear the hum, he wrote in an article, and they have described both as distinct sounds.

While the impact of low-frequency noise from various sources need further exploration, it's long been well known that prolonged exposure to certain noises

(https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hear) such as leaf blowers, can be hazardous to health, said

“There’s a level at which noise can become excessive and harmful, and that’s what we’re concerned with,” Banks said. “We’re concerned with noise at the point where it becomes harmful to health.”

N OISE POLLUTION, particularly low-frequency noise, has long received far less attention than air or water pollution. The task of regulating environmental noise is largely left to states and local governments, which set limits that often go unenforced.

A growing movement against the ever-increasing noise of all types in daily life is pushing for the federal government to declare it a public health problem. In June 2023, Quiet Communities filed suit against the Environmental Protection Agency in U.S. District Court in Washington, D.C., over the lack of noise pollution regulation.

Banks said communities are overwhelmed by low-frequency noise and noise in general. The job of ensuring noise stays within healthy levels belongs to the EPA, she said.

“The EPA has basically turned its back on an entire set of public health problems,” she said. “There are people suffering from noise. Noise is a public health problem and it’s an environmental problem.”

And while it's known that low-frequency noise may affect health, she said, it's vital that its long-term implications be fully explored. "It's chronic noise that can affect non-auditory health."

Woolworth, the acoustic engineer, said it also would take resources — and time — for communities to incorporate additional metrics that capture a wider range of frequencies. The current technique downplays low-frequency sounds over higher frequencies.

People who are affected by low-frequency noise may not so easily dismiss those unwanted sounds. Even noise-induced annoyance is a factor that "can and does" set up a stress reaction known as the "fight-or-

flight” response, Walker said. “If that stress response is constantly being stimulated, can we honestly say it doesn’t cause harm to health?”

And without regulation, Walker said communities are left to handle noise and raise awareness about how people can shield themselves from the impact of low-frequency noise. Her own experience living with the incessant muffled sounds from her upstairs neighbors and finding few resources to deal with the situation, was the catalyst that changed her career path. Now, through her work, she helps communities find ways to manage noise that is affecting their lives.

“As a researcher, if somebody tells me that noise is bothering them, I’m not going to take it lightly,” she said. “That is information that needs to be investigated.”

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