

What Research Says About the Public Health Dangers of Noise Pollution

Draft for Review: Compiled by Kevin J. Coyle, JD

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Prince William County Virginia has approved or is in the process of reviewing between 85 and 90 million square feet of data center buildings. The bulk of these centers will employ air cooling which means they will be fitted with rooftop blowers and chillers for heat expulsion. These rooftop installations, along with regular testing of backup diesel generators, noise coming from power substations and overhead power



lines, construction noise (over the next ten years or more) increased highway noise, the replacement of vegetative areas with hard surfaces, and the hum of data processors inside the buildings themselves will increase noise levels throughout the county. Protections will be needed particularly where these data centers have been approved in near proximity to schools, family neighborhoods, senior communities, public parks and others community places where there would be a normal expectation of lower noise levels.

Below is a compilation of research studies on how noise pollution affects human health. More specifically it, in several cases, quantifies or exemplifies how noise levels (highway noise, low frequency noise, and persistent noise) result in higher levels of stress related illness, (including hypertension and heart disease) sleep deprivation, cognitive and learning impairment in children, and premature death in adults. These research studies below are peer reviewed. It should be noted that the World Health Organization and the European Environmental Agency have compiled the most disciplined body of research on the subject of health effects of noise pollution. There is established comparability between the land use, transportation and urbanization issues in Europe and the United States. The U.S. has not invested nearly the same attention to the effects of noise pollution as other developed nations.

1. What is noise pollution and what are the health impacts?

According to the World Health Organization: "noise pollution is the presence of harmful or annoying noise in the environment. Main sources include transportation, industrial activities and urban development." The Environmental Protection Agency (EPA) defines [noise pollution](#) as "unwanted or disturbing sound."

The European Environmental Agency reports that noise ranks second only to air pollution as the environmental exposure most harmful to public health [Noise and Health | Harvard Medicine Magazine](#)



"There's no escaping the hum of traffic. In the Bridge Apartments, a cluster of four high-rise buildings straddling Interstate 95 in Manhattan, the rumble of cars and trucks driving by is so loud people have to raise their voices to talk. Even on the eighth floor, the noise level can be around 66 decibels — just less than a running vacuum. In the 1970s, a team of psychologists discovered that children living on the lower, noisier floors had a hard time distinguishing similar words, such as "thick" and "sick." They also had more difficulty reading than kids who lived on higher floors." [Noise Pollution Isn't Just Annoying — It's Bad for Your Health](#)

A 2017 meta review of noise impacts by Canadian researchers at the University of Guelph, points out that : "Noise represents an important public health problem that can lead to hearing loss, sleep disruption, cardiovascular disease, social handicaps, reduced productivity, negative social behavior, annoyance reactions, absenteeism and accidents. It can impair the ability to enjoy one's property and leisure time and increases the frequency of antisocial behavior." The study goes on to say: "The brain is always monitoring sounds for signs of danger, even during sleep. As a result, frequent or loud noise can trigger anxiety or stress. With continued exposure to noise pollution, a person's sensitivity to stress Increases. Noise adversely affects general health and well-being in the same way as chronic stress. It adversely affects future generations by degrading residential, social, and learning environments with corresponding economic losses." [\(PDF\) " Noise Pollution & Human Health: A Review " NAP2017paper HiralJariwala.pdf](#)

A 2022 article on the subject in Harvard Medicine Magazine says: "Researchers have found that the more people are bothered by noise, the greater the health risks they face from it. Yet, even those who tune out noise pollution, whether when awake or asleep, experience autonomic stress reactions." [Noise and Health | Harvard Medicine Magazine](#)

The Environmental Literacy Council, an organization of scientists including public health specialists reports: “Noise pollution, often overlooked as a less tangible environmental threat, exerts a substantial and far-reaching impact on human health. From the immediate damage to hearing to its broader systemic effects on cardiovascular health, sleep quality, cognitive function, and mental well-being, noise is a pervasive force undermining our overall health and quality of life.

The most direct and readily apparent health consequence of noise pollution is **hearing loss**. Prolonged exposure to high-intensity sound levels can damage the delicate structures of the inner ear, specifically the hair cells responsible for converting sound vibrations into electrical signals that the brain can interpret. This damage can result in both temporary and permanent hearing impairment.

Chronic exposure to noise pollution can elevate blood pressure, increase heart rate, and disrupt normal blood flow. These changes put increased strain on the cardiovascular system, escalating the risk of developing **cardiovascular diseases** such as hypertension (high blood pressure), coronary artery disease, and heart attacks. Studies have consistently linked exposure to traffic noise and other environmental noises to an increased incidence of cardiovascular events.

Noise pollution is a major culprit in **sleep disturbances**. Even relatively low-level background noise can make it difficult to fall asleep, stay asleep, or achieve restful, restorative sleep. These sleep disturbances are not merely inconvenient; they have profound implications for overall health and cognitive function. Chronic sleep deprivation can lead to fatigue, impaired concentration, mood swings, reduced cognitive performance, and increased susceptibility to illness. Noise during sleep disrupts sleep stages, particularly slow-wave sleep, which is crucial for physical recovery and memory consolidation.

The impact of noise pollution on cognitive function is particularly concerning for children. Exposure to noisy environments, whether at home or in the classroom, has been linked to **reduced cognitive performance**, including problems with attention, memory, and language acquisition. Children living near airports, busy roadways, or other sources of significant noise pollution tend to perform worse on standardized academic tests.

Certain populations are particularly vulnerable to the adverse health effects of noise pollution. **Children**, with their still-developing nervous and cognitive systems, face unique challenges. **The elderly**, often with pre-existing health conditions, are also more susceptible to the cardiovascular and sleep-related consequences of noise. **Individuals working in noisy industries**, as previously mentioned, face a higher risk of hearing loss. In addition, **people living in densely populated urban areas** or near major transportation corridors often experience the greatest burden of noise pollution. Socioeconomic factors can also play a role, with

disadvantaged communities often bearing the brunt of environmental noise.” [How Does Noise Pollution Affect Human Health? - The Environmental Literacy Council](#)

“That noise has biological effects beyond the ear makes sense in evolutionary terms”. Noise and sleep researcher Mathias Basner of the University of Pennsylvania and his colleagues put it in a 2014 [Lancet](#) review, “evolution has programmed human beings to be aware of sounds as possible sources of danger.” [Turning Down the Noise Around You Improves Health in Many Ways | Scientific American](#)

In 2018, in the Journal of the American College of Cardiology – Researchers reported that: “[Epidemiological studies](#) have found that environmental noise is associated with an increased incidence of arterial hypertension, [myocardial infarction](#), heart failure, and stroke. Observational and translational studies indicate that especially nighttime noise increases levels of stress hormones and vascular [oxidative stress](#), which may lead to [endothelial dysfunction](#) and arterial hypertension”

“Estimates hold that chronic noise exposure contributes to 48,000 new cases of heart disease in Europe each year and disrupts the sleep of 6.5 million people. Quantifying noise pollution’s contribution to health problems and death in the United States, however, remains a challenge because of poor measuring and monitoring”, says Peter James, an HMS associate professor of population medicine in Harvard Pilgrim Health Care Institute’s Department of Population Medicine. [Environmental Noise and the Cardiovascular System - ScienceDirect](#)

In 2013, in a TED blog, Kate T. May wrote about some other impacts of noise:

“The estimated cost of noise pollution is \$30.8 billion a year — and that’s just in Europe. The World Health Organization Europe’s 2011 report, ‘[Burden of disease from environmental noise](#),’ analyzes the relationship between environmental noise and health. In this study, they calculate the financial cost of lost workdays, healthcare treatment, impaired learning and decreased productivity due to noise. The total they came up with is staggering, considering they’re looking at just one continent.

Each year, noise pollution takes a day off the life of every adult and child in Europe. This same study also looked at the cost of noise pollution in terms of lost life expectancy. Shockingly, they determined that every 365 days, one million years are taken off European’s collective life expectancy — averaging to a day per person.

A 20 decibel increase in aircraft noise is enough to delay a student’s reading level by up to 8 months. A study [published in the American Journal of Epidemiology](#) in 2006 looked at 2000 students between the ages of 9 and 10 in schools in The Netherlands, Spain and the U.K. — many in schools near airports. They found that aircraft noise was associated with impaired reading comprehension.

3% of cardiac arrest cases in Germany have been explicitly linked to traffic noise. Treasure this alarming fact came from 2009 [press release from the Environmental Protection UK.](#)

The WHO has documented several categories of adverse health effects of noise pollution on humans as well.

- Hearing Impairment
- Negative Social Behavior and Annoyance
- Interference with Spoken Communication
- Sleep Disturbances
- Cardiovascular Disturbances
- Disturbances in Mental Health

Construction Activity Noise

"Noise pollution caused by construction activities in urban areas is a serious problem. Construction noise can affect human health and well-being negatively. This study utilized physiological data including heart rate parameters, Respiratory Rate (RR), and Electrodermal Activity (EDA) to explore the effects of construction noise on human health. Different construction noise types (saw, jackhammer, pile driver, bulldozer), levels (55, 65, 75 and 85 dBA), and exposure durations (30, 60, 120, and 180 s) were examined in a lab-based experiment. The noise conditions were reproduced for twenty-three participants through speakers. To statistically analyze the changes in the physiological measures caused by the examined noise conditions, mixed models were utilized. The results revealed significant effects of the construction noise types on heart rate parameters including heart rate (HR), high frequency (HF), and standard deviation of the normal beat intervals (SDNN). In addition, the results showed that exposure duration significantly affects [physiological responses](#), including RR and SDNN." [Construction noise effects on human health: Evidence from physiological measures - ScienceDirect](#)

2. What mechanisms in the brain and human physiology involuntarily react to noise:

The University of Guelph meta-analysis note above also said: "The brain is always monitoring sounds for signs of danger, even during sleep. As a result, frequent or loud noise can trigger anxiety or stress. With continued exposure to noise pollution, a person's sensitivity to stress [increases](#)."

Noise represents an important public health problem that can lead to hearing loss, sleep disruption, cardiovascular disease, social handicaps, reduced productivity, negative social behavior, annoyance reactions, absenteeism and accidents. It can impair the ability to enjoy one's property and leisure time and increases the frequency of antisocial behavior. Noise adversely affects general health and well-being in the same way as does chronic stress. It adversely affects future generations by degrading residential, social, and learning environments with corresponding economic losses." [\(PDF\) " Noise Pollution & Human Health: A Review "](#)

Ahmed Tawakol, an HMS associate professor of medicine at Massachusetts General Hospital, and Michael Osborne, an HMS instructor in medicine at Mass General, have used advanced PET scanning (Editorial note: a positron emission tomography (PET) scan is an imaging test that can help reveal the metabolic or biochemical function of the body's tissues and organs.) to show that transportation noise is associated with heightened activity of the amygdala relative to regulatory cortical regions. (Editorial note: Your amygdala is a small, almond-shaped structure inside of your brain. It's part of a larger network in your brain called the limbic system. When it comes to your survival, your amygdala and limbic system are extremely important. These are parts of your brain that automatically detect danger. They also play a role in behavior, emotional control and learning.) Amygdalar activity can trigger stress pathways, including inflammation, that can lead to cardiovascular and metabolic diseases. Participants with a higher ratio of amygdalar to cortical activity had more risk for adverse outcomes in follow-up. The link persisted even after accounting for other disease risk factors." [Noise and Health | Harvard Medicine Magazine](#)

Noise affects sleep quality: "The sympathetic nervous system maintains lighter stages of sleep when the body is exposed to noise, which does not allow blood pressure to follow the normal rise and fall cycle of an undisturbed [circadian rhythm](#)."^[3]
https://en.wikipedia.org/wiki/Adverse_effects

Classroom listening and comprehension: "In a New York classroom, noise levels were so high that the teacher had to scream to be heard. The classroom was located near a subway train on raised tracks which passed by Public School 98 in Manhattan about 15 times a day, causing constant interruptions in the learning process. For many years, people had complained about the noise levels at Public School 98, and in 1975, Arline Bronzaft, associate professor of psychology at Herbert H.

Lehman College of the City University of New York, published a study examining the impact of noise on children's reading ability. She found that students who sat on the noisy side of the school building adjacent to the tracks performed poorly on reading tests compared to those on the quiet side of the building. The average reading scores of the classes on the noisy side lagged three to four months behind those of students on the quieter side. As a result of Bronzaft's findings, the Transit Authority installed rubber pads on the tracks to reduce noise, and the Board of Education equipped classrooms with sound-absorbing materials to create a better learning environment."

"The average noise level in many classrooms is not just associated with impaired learning — but with permanent hearing loss. Noise can deeply affect learning too. The WHO recommends a noise level in classrooms akin to that you'd find in a library — 35 decibels. However, a study in Germany found that the actual average noise volume in classrooms is 65 decibels — a level associated with permanent hearing loss. For a student sitting in the fourth row of a traditional classroom, speech intelligibility is just 50 percent — meaning that they only hear half of what their teacher says." [How traffic noise hurts children's brains](#)

3. What are the unique health threats of low-frequency noise?

"A silent menace lurks in the background of modern life, its unseen vibrations wreaking havoc on our minds and bodies. Low-frequency sound, an often-overlooked aspect of our acoustic environment, has the power to influence our psychological well-being in ways we're only beginning to understand. From the rumble of traffic outside our windows to the hum of household appliances, these subtle sonic intruders are omnipresent, shaping our experiences and potentially impacting our mental health.

Urban environments are particularly rife with low-frequency noise. Traffic, construction, and industrial activities all contribute to a constant background of low-frequency vibrations. It's like living in a giant, vibrating bowl – the sounds may not always be loud, but they're always there, subtly influencing our psychological state.

Low frequency sound refers to acoustic waves with frequencies below 200 Hz.

On a broader scale, urban planning and policy considerations are crucial for controlling low frequency noise pollution. This might involve implementing stricter noise regulations, redesigning urban spaces to minimize sound transmission, or investing in quieter technologies. It's about creating environments that support psychological well-being rather than undermining it.

To understand the psychological impact of low-frequency sound, we first need to grasp how our bodies perceive these vibrations. Our auditory system is a marvel of evolution, capable of detecting a wide range of frequencies. However, when it comes to low frequency sounds, our

ears aren't always the primary receptors. This whole-body perception of low-frequency sound is part of what makes it so impactful on our psychological state. It's not just an auditory experience; it's a full-body sensation that can trigger a range of physiological and psychological responses.

One of the most immediate effects of exposure to low-frequency sound is cognitive impairment. Studies have shown that prolonged exposure to low frequency noise can negatively impact concentration, memory, and decision-making abilities. Low-frequency sound can also have a profound impact on our emotional state. Many people report feeling increased anxiety, irritability, and mood swings when exposed to persistent low frequency noise.

Sleep disturbances are another common complaint associated with low-frequency sound exposure. The persistent vibrations can make it difficult to fall asleep or stay asleep, leading to fatigue and further exacerbating cognitive and emotional issues. It's a vicious cycle. Perhaps most concerning is the potential for low frequency sound to trigger stress responses in the body. Prolonged exposure has been linked to increased cortisol levels, indicating a physiological stress response." <https://neurolaunch.com/psychological-effects-of-low-frequency-sound/>

In a 2020 meta review of low-frequency sound health research literature by European researchers: "Of the 39 articles that were included in the evaluation of this article, it was observed that the main effects on human health (of exposure to low-frequency noise) are more prevalent in aspects such as sleep disorders (11.7%), discomfort, sensitivity and irritability to noise (10%), annoyance (13.3%), stress (6.7%), hearing loss (8.3%), reduced performance/fatigue (5%), heart rate/cardiovascular diseases (10%), tension and blood pressure (6.7%), anxiety (1.7%), depression (3.3%), imbalance (3.3%), and mental performance (6.7%).

There were also other effects (of low-frequency noise) on human health but with an incidence in very specific aspects (13.3%), such as the frequency of chromosomal aberrations in bone marrow cells, excess bilirubin, peptic ulcers (gastric and duodenal), effects on the cerebral blood barrier, hemodynamic events, (blood flow disruption) irreversible imbalance with structural damage to the otoconial membrane, tinnitus and sound reconversion therapy, and vocal disorders and effort.

Only the effects on human health related to sleep disturbance, noise discomfort, annoyance, hearing loss, and cardiovascular disease were analyzed, as these were the themes where a greater number of articles were observed, thus allowing a better comparison and evaluation between the various articles.

In the case of impacts on sleep disturbance, a dependence on the distance to the source of noise was observed; that is, the greater the proximity to the source, the greater the effects on sleep, as established by [41,43] With long-term noise exposure, noise sensitivity is lower, which reduces the effects on sleep disturbance, as determined by [44]. Exposure to noise at night disturbs sleep and causes more frequent awakenings, less deep and non-continuous sleep, and morning tiredness in the participants, as discussed by [42,47].

With increasing age, especially for people over the age of 65, exposure to noise causes sleep disturbances, which adds to the demand for sleeping pills and antidepressants, as determined by [45]. According to [46], the average noise levels exceeded the levels for sleep disturbances established for human health." [Low-Frequency Noise and Its Main Effects on Human Health—A Review of the Literature between 2016 and 2019](#) [applsci-10-05205-v2.pdf](#)

4. What is the impact of noise on older residents?

Since before 2000, Prince William County has had an affirmative policy of encouraging the development of senior living communities including several in the Gainesville and Haymarket areas. The location of these communities often coincides with the location of some of the largest proposed concentrations of data centers in the County. This raises the question of whether there are unique vulnerabilities that older residents have to noise pollution such as would come from proximity to large air-cooled data centers. Consider:

“Why are seniors more vulnerable?”

While you may not be greatly affected by a TV playing or idle background chatter, the same cannot be said for many seniors. Here are 4 reasons why seniors are more vulnerable to the effects of noise, which may help you better understand the experiences of older adults suffering from hearing loss.

Age-related hearing loss, also known as *presbycusis*.

As individuals age, the structures of the inner ear naturally undergo changes, resulting in a gradual decline in hearing abilities. This age-related hearing loss makes it more challenging for seniors to filter out background noise and focus on relevant sounds. Consequently, they may experience difficulties in understanding speech, following conversations, and distinguishing important auditory cues from surrounding noise.

Cumulative lifetime noise exposure

Throughout their lives, seniors may have been exposed to various occupational and environmental noise sources, such as industrial machinery, construction sites, or loud recreational activities. This cumulative noise exposure can lead to hearing damage over time, further compromising their ability to cope with and tolerate noisy environments.

Decline in physiological resilience

Seniors may have reduced coping mechanisms and a decreased ability to adapt to environmental stressors, including noise. This diminished resilience makes them more susceptible to the adverse effects of noise.

Dementia

Older individuals with dementia are even more susceptible to the detrimental effects of noise pollution due to the cognitive and sensory impairments associated with the condition. Dementia

affects their ability to filter out irrelevant stimuli and process sensory information effectively, making it challenging for them to cope with excessive noise."

[Road traffic noise and cognitive function in older adults: a cross-sectional investigation of The Irish Longitudinal Study on Ageing | BMC Public Health | Full Text](#)

5. What is the role of government versus an individual in noise reduction and protection?

According to health practitioners interviewed in the Harvard article: "We want our patients to reduce their exposure as much as possible, such as wearing ear plugs or investing in soundproofing insulation, but that's not possible for many who live in the noisiest areas," he says. "To say the onus is on the individual to fix their noise exposure is not feasible." [Noise and Health | Harvard Medicine Magazine](#)

The World Health Organization says: "The aim of enlightened governmental controls should be to protect citizens from the adverse effects of airborne pollution, including those produced by noise. People have the right to choose the nature of their acoustical environment; it should not be imposed by others."

The World Health Organization calculated that in 2018 in Europe: "1.6 million years of healthy life were lost because of traffic noise." The organization recommended that to avoid these health effects, exposure to road traffic noise should be limited to below a weighted 24-hour average of 53 dB (the volume of a campfire from about 16 feet away) during the day, evening and night and 45 dB specifically at night (the volume of light traffic about 100 feet away). [Turning Down the Noise Around You Improves Health in Many Ways | Scientific American who compendium noise 01042022.pdf](#)

More specifically the WHO identified standards for different noise producers:

Road traffic: For average noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic below 53 dB, as road traffic noise above this level is associated with adverse health effects. For night noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic during night time below 45 dB, as road traffic noise above this level is associated with adverse effects on sleep.

Railways: For average noise exposure, the GDG strongly recommends reducing noise levels produced by railway traffic below 54 dB, as railway noise above this level is associated with adverse health effects. For night noise exposure, the GDG strongly recommends reducing noise levels produced by railway traffic during night time below 44 dB, as railway noise above this level is associated with adverse effects on sleep.

Aircraft: For average noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft below 45 dB, as aircraft noise above this level is associated with adverse health effects. For night noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft during night time below 40 dB, as aircraft noise above this level is associated with adverse effects on sleep.

Wind Turbines: For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB, as wind turbine noise above this level is associated with adverse health effects.

The guideline recommendations provide a useful tool for national and local authorities when deciding about noise reduction measures, as they provide data to estimate the health burden on the population and therefore allow comparison among different policy options. These options can include measures to reduce the noise emitted by the sources, measures aimed at impeding the transmission of noise from the sources to people and measures aimed at better planning the location of houses (urban planning)

The first principle is to reduce exposure to noise, while conserving quiet areas. The recommendations focus on reduction of population exposure to environmental noise from a variety of sources, in different settings.

The second principle is to promote interventions to reduce exposure to noise and improve health. The evidence from epidemiological studies on adverse health effects at certain noise levels, used as a basis to derive the guideline values proposed in the recommendations, supports the promotion of noise interventions.

The third principle is to coordinate approaches to control noise sources and other environmental health risks. Considering the common transport-related sources of environmental noise and air pollution, and in particular the evidence of independent effects on the cardiovascular system, a coordinated approach to policy development in the sectors related to urban planning, transport, climate and energy should be adopted for policies with an impact on environmental noise, air quality and/or climate.

The fourth principle is to inform and involve communities that may be affected by a change in noise exposure. In planning new urban and/or rural developments (transport schemes, new infrastructures in less densely populated areas, noise abatement and mitigation strategies), bringing together planners, environmental professionals and public health experts with policy-makers and citizens is key to public acceptability and involvement and to the successful guidance of the decision making process.”

Conclusion: There is a solid body of compelling, peer-reviewed, evidence supporting Prince William County's efforts to manage noise levels coming from such sources as industrial scale data centers. The health effects of noise over certain levels, including low frequency noise, contribute to severe health problems in adults and the elderly and cause developmental learning and sleep disruptions in children. These can lead to serious illness and premature death if not managed and controlled effectively.

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Additional Research Resources:

Noise and health research from Wikipedia article:

1. Baumgaertner, Emily; Kao, Jason; Lutz, Eleanor; Sedgwick, Josephine; et al. (June 9, 2023). ["Noise Could Take Years Off Your Life Here's How"](#). *The New York Times*. [Archived](#) from the original on June 9, 2023.
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