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ENVIRONMENTAL NOISE EXPOSURE AND CARDIOVASCULAR DISEASE: A REVIEW OF CURRENT EVIDENCE

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ABSTRACT

Noise is a widespread problem worldwide, only expected to grow due to the accelerating urbanization. Although not as well-documented as air pollution, there is substantial evidence of its detrimental effects on health. The effects of noise are usually divided into auditory and non-auditory ones, with cardiovascular disease, this review's main focus, being the most prevalent and well-researched among the latter. There is strong evidence for noise being a risk factor of cardiovascular diseases such as ischemic heart disease, myocardial infarction, and stroke. As the body of evidence grows, we are beginning to better understand not only the effects but also the mechanisms by which noise impacts one's health. Cardiovascular diseases seem to be caused, among others, by excessive oxidative stress, endothelial dysfunction, and an increase in stress hormones and inflammatory mediators, which in turn promote atherosclerosis and elevate blood pressure. In this review, we will first show the extent to which noise has become a prevalent problem, then discuss possible mechanisms underlying the pathophysiology of noise-related cardiovascular disease, and present evidence for their association. Then, we will outline the areas of research with limited evidence or warrant further examination.

KEYWORDS

Environmental Noise, Noise Pollution, Cardiovascular Disease, Cardiovascular Risk, Myocardial Infarction, Hypertension

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Introduction

According to the WHO, ≥1.6 million healthy life-years are lost annually from traffic-related noise in Western Europe (van Kempen et al., 2018). Noise is defined as unwanted and harmful sound and includes transportation, residential, industrial, occupational, and leisure noise (Basner et al., 2014). A 2016 European Quality of Life survey shows how prevalent the problem is, with more than 32% of participants reporting noise problems in their immediate neighborhood (Ahrendt et al., 2018). Environmental noise is a well-established risk factor of various auditory (Chen et al., 2020; Ding et al., 2019; Xu et al., 2023) and non-auditory diseases (Basner et al., 2014; Sa & Mp, 2003). There has also been a focus on the effects of noise on mental health, including suicide (A. Li et al., 2022; Seidler et al., 2017; Wicki et al., 2023). For years now, various organizations, including the WHO, have been creating new regulations in an attempt to mitigate the detrimental effects of noise pollution (*Guidance on Environmental Noise*, n.d.). One of the most prevalent and best-researched areas of non-auditory diseases is cardiovascular disease (CVD) (Tabaei et al., 2025; Thacher, Poulsen, et al., 2022a). This review is based on current literature on the mechanisms and epidemiology of CVD arising as an effect of noise and will focus on prevalent diseases such as stroke, myocardial infarction, and ischemic heart disease.

Methods

We conducted a search on PubMed databases with combinations of the keywords: "noise", "atherosclerosis", "cardiovascular disease", "hypertension", "stroke", "myocardial infarction", "ischemic heart disease", "diabetes" from the years 2016 to 2026. Then, the articles were manually searched and selected based on their relevance to the review, i.e., those concerning the pathophysiology of the stress response, noise epidemiology, the link between noise and cardiovascular diseases, etc. We also conducted a search among the articles referenced in the primary ones, regardless of the publication date. Finally, 71 articles were selected.

The mechanisms of the response to noise

The mechanisms through which noise can cause cardiovascular diseases have been studied for a long time. They arise as a consequence of various physiological and pathological responses to noise. As is well understood now, according to the noise/stress hypothesis introduced by Babisch, noise, especially the chronic one, can activate the pituitary-adrenal-cortical axis and the sympathetic-medullary-adrenal axis. Moreover, chronic low noise can lead to sleep disturbances and communication disruptions, which in turn activate the aforementioned axis. This can lead to increased levels of various stress hormones, including cortisol and catecholamines, which may then raise blood pressure, promote oxidative stress, or accelerate atherosclerosis (Babisch, 2002).

Noise has been shown to promote endothelial dysfunction (Daiber et al., 2019). Endothelial dysfunction, in turn, has been shown to be a good marker of oxidative stress (Münzel et al., 2018). As it has been previously said, noise acts as a stressor- an acute or chronic one. Stress has been shown to impair the function of endothelium, possibly by stimulating the pituitary-adrenal-cortical axis, leading to the reduction of the bioavailability of nitrous oxide and the promotion of oxidative stress (Poitras & Pyke, 2013). Oxidative stress is well known to be a factor promoting atherosclerosis (Batty et al., 2022).

Moreover, stress has been shown to cause an increase in inflammatory mediators, such as interleukins, which can further impair the function of endothelium (Aschbacher et al., 2012; Szabo et al., 2020). Repeated endothelial dysfunction can lead to atherosclerosis (Ghiadoni et al., 2000), which, in turn, increases the incidence of cardiovascular diseases.

As noise leads to an increase in cortisol levels, it alters blood lipid and lipoprotein levels (Qureshi et al., 2009). It has been shown that exposure to industrial noise can cause an increase in triglyceride levels (Mehrdad et al., 2011). Both of those changes can promote atherosclerosis.

Another marker, mostly associated with the function of the autonomic nervous system (ANS), is heart rate variability (HRV). ANS consists of two parts- an inhibitory parasympathetic nervous system and an excitatory sympathetic nervous system. The ability of an individual to adapt to stress, psychological or physical, that is, to freely increase the sympathetic or parasympathetic stimulation, is reflected by higher values of HRV (Appelhans & Luecken, 2006). It has been shown that low heart rate variability, a marker of the organism's lack of adaptability, increases the risk of myocardial infarction (Buccelletti et al., 2009). Noise has been shown to decrease HRV (Kraus et al., 2013; Lee et al., 2010), thus increasing the risk of cardiovascular episodes.

The influence of noise on cardiovascular disease risk factors

Arterial hypertension

As it is well known, high blood pressure is one of the leading causes of cardiovascular disease (Chobanian et al., 2003). In one study, noise was found to increase the systolic and diastolic pressure by 4 mmHg in men and 2 mmHg in women (Paunović et al., 2014). A meta-analysis has concluded that the risk of hypertension increases by 3,4% for every 5 dBA increase in noise (van Kempen & Babisch, 2012). A study on over half a million individuals from the UK Biobank showed adverse effects of noise on blood pressure (Kupcikova et al., 2021). In various cross-sectional studies noise has been found to be a significant risk factor of hypertension (Bolm-Audorff et al., 2020). High blood pressure can also promote atherosclerosis by damaging the endothelium (Durante et al., 2024).

Diabetes mellitus

Type 2 diabetes (DM2) has become a very prevalent disease, with over 40 million, or 12 percent, of US citizens being affected by it (Baumblatt et al., 2024). The association between diabetes mellitus and cardiovascular disease is well established (Henning, 2018; Htay et al., 2019). Noise has been shown to be a risk factor of diabetes (Wang et al., 2020). One meta-analysis found a 6 percent increase in the risk of diabetes for every 5 dBA increase in exposure, with a stronger association with air traffic noise (Zare Sakhvidi et al., 2018). Another, newer study has found a 6 percent increase, but for every 10 dBA increase in exposure to noise (Liu et al., 2023). A cohort study has observed a strong association between noise exposure and the incidence of diabetes mellitus (Shin et al., 2020). Although most studies show a correlation between noise and the incidence of DM2, some have found no such connection (Kacem et al., 2021) or found the evidence to be of low quality (Rahmanian et al., 2023).

Sleep disturbances and mental health

What might be one of the most obvious effects of environmental noise is sleep disturbance. A recent update to a WHO systematic review and meta-analysis, including 36 studies, has shown that, according to the evidence, transportation noise is negatively correlated with self-reported sleep (Smith et al., 2022). Both low sleep quality and quantity are linked to poor mood, decreased quality of life, and possibly to cardiovascular disease risk. This might be due to increased cortisol levels and sympathetic activity (Khan & Aouad, 2022). A lack of sleep has been associated with a higher risk of hypertension, type-2 diabetes, coronary heart disease and stroke (Miller & Howarth, 2023).

Noise can also impact the mental health of those exposed. Depression is the most well- researched mental health disease when it comes to its connection to noise. Our understanding of depression shows us that it is not limited to the central nervous system, but acts as a risk factor of somatic diseases and may aggravate their course. Depressed individuals not only exhibit a higher susceptibility to developing cardiovascular diseases, but also have a higher risk of mortality when already affected by them (X. Li et al., 2023). Depression has been associated with a higher risk of stroke, myocardial infarction, congestive heart disease, and higher cardiovascular disease mortality (Krittanawong et al., 2023). Noise has been shown to negatively impact mental health (A. Li et al., 2022). One meta-analysis showed that long exposure to environmental noise increases the risk of depression (Hu, 2025). Another one showed a connection, although with very low-quality evidence (Dzhambov & Lercher, 2019). Other studies also found noise to be an independent risk factor of depression (Heinonen-Guzejev et al., 2023; Seidler et al., 2017; Shi et al., 2023).

Noise and cardiovascular diseases

One nationwide Swiss study on over 4 million subjects found an increase in risk of myocardial infarction between 1,8% to 3,8% (depending on the type of noise) for every 10 dBA increase in noise exposure (Vienneau, Saucy, Schäffer, Flückiger, Tangermann, Stafoggia, Wunderli, & Röösli, 2022). A nationwide study from Denmark has shown an association between noise and myocardial infarction, angina pectoris, and heart failure (Thacher, Poulsen, et al., 2022b). Noise exposure has also been linked with an increased risk of stroke (Fu et al., 2022; Sørensen et al., 2021; Weihofen et al., 2019; Yankoty et al., 2022). A meta-analysis of cohort studies has shown that noise annoyance was associated with a higher risk of atrial fibrillation (Song et al., 2022).

The outcomes are not unanimous, though, with some studies finding no correlation between noise and CVD (Andersson et al., 2020; Pyko et al., 2019; Thacher, Roswall, et al., 2022).

One study showed an increase in CVD mortality as a result of noise starting below current guideline limits (Vienneau, Saucy, Schäffer, Flückiger, Tangermann, Stafoggia, Wunderli, Röösli, et al., 2022).

Discussion

Noise is a risk factor of various cardiovascular diseases, which are the leading cause of mortality worldwide according to the WHO (*Leading Causes of Death*, n.d.). There is still a need for more studies researching the extent to which noise causes cardiovascular diseases, especially with some of them, such as atrial fibrillation, having very scarce evidence. Moreover, there is still limited research on other possible mechanisms through which noise affects one's organism, such as its influence on DNA (Eze et al., 2020).

As worldwide urbanization accelerates, noise will become an increasingly prevalent risk factor of CVD. There also seems to be a need to revise noise guidelines and limits, which, as has been shown, are currently too high according to some studies. It is also important to focus on children, as they may be more susceptible to noise, and its effects may differ from those in adults (S & C, 2015). Pregnant women may be another susceptible group, with one study finding the odds of gestational diabetes mellitus occurring higher in women exposed to railway noise (Thacher et al., 2021). Although the concern of this review was cardiovascular disease, as acknowledged before, there is an established connection between noise and other non-auditory diseases, of which those concerning mental health seem to be the most well-researched. Apart from depression, noise also shows an association with the risk of suicide (Wicki et al., 2023).

It is important to remember that lower income, lower education, and a lower overall socioeconomic status are associated with higher noise exposure (Casey et al., 2017; Collins et al., 2020; Hayward & Helbich, 2024). Noise may also predispose to having harmful lifestyle habits, with one study showing that residential traffic noise is associated with higher alcohol consumption and smoking habits (Roswall et al., 2018). It is yet another thing that adds to the environmental injustice that further aggravates the disparities between people with different socioeconomic statuses.

There is also some research challenging the established view on noise. Some papers point to noise sensitivity rather than the noise level itself as the main risk factor for non-auditory effects (Park et al., 2017; Stansfeld et al., 2021). One paper has shown that it is not the neighborhood's density, but its qualities, such as socioeconomic factors, that are crucial to its effect on the population (Generaal et al., 2019).

Moreover, noise pollution and air pollution have been found to work synergistically in the induction of the onset and progression of CVD (Fuks et al., 2017; Kuntic et al., 2025), so it might be important to view and fight them collectively.

Conflict of interest: The authors declare no conflicts of interest.

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