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Review

Health effects from low-frequency noise and infrasound in the general population: Is it time to listen? A systematic review of observational studies

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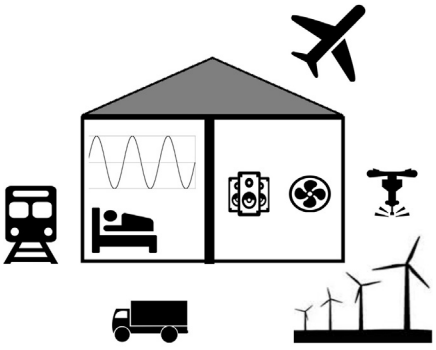
HIGHLIGHTS

- A part of the population reports high annoyance attributed to LFN sources.
- LFN is associated with self-reported outcomes, mainly neurological.
- Current evidence is very limited, especially regarding chronic conditions.
- More epidemiological research on LFN and health effects is needed.

GRAPHICAL ABSTRACT



Low-frequency noise in everyday life and health effects:
Many potential sources but little epidemiological research

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ABSTRACT

A systematic review of observational studies was conducted to assess the association between everyday life low-frequency noise (LFN) components, including infrasound and health effects in the general population. Literature databases Pubmed, Embase and PsycInfo and additional bibliographic sources such as reference sections of key publications and journal databases were searched for peer-reviewed studies published from 2000 to 2015. Seven studies met the inclusion criteria. Most of them examined subjective annoyance as primary outcome. The adequacy of provided information in the included papers and methodological quality of studies was also addressed. Moreover, studies were screened for meta-analysis eligibility. Some associations were observed between exposure to LFN and annoyance, sleep-related problems, concentration difficulties and headache in the adult population living in the vicinity of a range of LFN sources. However, evidence, especially in relation to chronic medical conditions, was very limited. The estimated pooled prevalence of high subjective annoyance attributed to LFN was about 10%. Epidemiological research on LFN and health effects is scarce and suffers from methodological shortcomings. Low frequency noise in the everyday environment constitutes an issue that requires more research attention, particularly for people living in the vicinity of relevant sources.

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Contents

1. Introduction

Unlike several other environmental stressors, noise pollution, especially in the urban environment, is still increasing (Öhrström et al., 2006; WHO, 2011). Well-documented evidence supports an association between higher levels of environmental noise and various adverse health effects, such as cardiovascular diseases (Münzel et al., 2014), sleep quality (de Kluizenaar et al., 2009; Omlin et al., 2011; van Kamp and Davies, 2013), annoyance (Miedema and Oudshoorn, 2001; van Kamp et al., 2004; Frei et al., 2014) and also cognitive development and hyperactivity in vulnerable population groups such as children (van Kamp and Davies, 2013; Basner et al., 2014).

Noise ranks among the environmental stressors with the highest public health impact (WHO, 2011) and it is therefore important to regularly monitor for the determination and comprehension of possible effects on health. An underinvestigated noise component in relation to health effects is low frequency noise (LFN) (sound below 250 Hz), including infrasound (up to 20 Hz) (Berglund et al., 1996; Leventhall, 2004). Although LFN is audible at sufficiently high pressure levels (decibels, dB), it can also occur below the human hearing threshold (Leventhall, 2007), considering that the human ear responds better to sound frequencies between 500 Hz and 8 kHz (Farina, 2014).

Sounds within the low-frequency sound spectrum comprise a common, everyday-life environmental exposure, produced by natural (sea waves, wind turbulence) as well as by man-made sources (industrial installations, domestic appliances, transportation) sources. The latter constitute the primary cause of LFN (Berglund et al., 1996), while the rapid expansion of infrastructure has increased the attribution of symptoms to LFN and public concern (Jakobsen, 2012). According to earlier evidence from local environmental health authorities, complaints due to LFN comprise about 35% of the total noise complaints filed (Bengtsson and Waye, 2003). Low frequency noise in the residential environment is described as a constant, deep and humming/rumbling sound and although complainants perceive it with their ears, the perception of bodily or external vibration is also possible (Møller and Lydolf, 2003). Annoyance is usually the first reaction to this type of noise, often accompanied by secondary effects, such as headache, concentration difficulties palpitations and sleep problems (Møller and Lydolf, 2003; Leventhall, 2009).

A number of studies suggest an association between LFN and various physiological and psychological reactions such as annoyance, hearing threshold shift, concentration problems, lower sleep quality, mood effects (Persson Waye et al., 1997; Ising and Ising, 2002; Leventhall, 2004; Pawlaczyk-Łuszczyńska et al., 2005) and also controversial conditions such as the so-called vibro-acoustic disease (Alves-Pereira and Branco, 2007; Chapman and St George, 2013). Additionally, adverse health effects from occupational exposure have been observed on memory, annoyance and performance (Gomes et al., 1999; Persson Waye et al., 2001; Bengtsson et al., 2004; Kaczmarska and Łuczak, 2007; Pawlaczyk-Luszczynska et al., 2009). Evidence on vascular and respiratory effects is inconclusive (Schust, 2004).

Although the potential impact of LFN as environmental pollutant has been highlighted by the WHO (Berglund et al., 1999), current evidence is mainly based on case studies and laboratory experiments of small sample sizes and short exposure sessions (Leventhall, 2009; Ambrose et al., 2012). It is therefore unknown to what extent such health effects occur in relation to everyday-life exposure to LFN at the population level. Observational studies are highly important due to the investigation of everyday-life exposure and effects in larger samples.

No systematic evaluation of the peer-reviewed observational epidemiological literature has been performed up to date on the association between LFN and health. The present paper aims to fill this gap in the literature.

2. Methods

2.1. Data sources and search

Pubmed, Embase and PsycInfo were searched as primary databases for relevant studies published between January 1st, 2000 and January 30th, 2015. There was no a-priori language restriction.

A wide range of (combined) keywords was used, related to environmental noise exposure and health effects, presented in Table 1. In addition to the electronic database searches, the reference sections of previous systematic reviews and key papers were examined. The databases of the following relevant journals were also searched: Noise and Health, The Journal of the Acoustical Society of America, Journal of Low Frequency Noise, Vibration and Active control, Journal of Environmental Psychology.

2.2. Inclusion criteria

For paper selection, four criteria were used:

I. *An exposure criterion*. Only studies examining health effects in relation to exposure to low-frequency noise and/or infrasound (up