



Low frequency noise in relation to health effects: A systematic review

Christos Baliatsas

Centre for Sustainability, Environment and Health, National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

Irene van Kamp

Centre for Sustainability, Environment and Health, National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

Ric van Pol

Centre for Sustainability, Environment and Health, National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

1. Introduction

The level of concern and health complaints related to low frequency noise (LFN) are increasing, not only in the Netherlands, but also at international level. It is not clear in the scientific literature whether daily life LFN is associated with health effects such as hearing loss, vertigo, balance problems, respiratory effects and vibro-acoustic disease. No systematic evaluation of the literature has been performed, focusing on epidemiological studies of residential sources of LFN in relation to various symptoms and well-being indicators. A systematic review of observational studies was conducted in order to address the strength of evidence for an association between low frequency noise and health effects in the general population.

2. Methods

2.1. Data sources and search

The following databases were searched for relevant studies published between January 2000 and January 2015: Pubmed, Embase and PsycInfo as primary databases, and also Scopus and Web of Science. There was no language restriction.

A wide range of 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, key papers and proceedings of key conferences such as INTERNOISE and EuroNoise. The databases of the following journals were additionally 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 general population exposure to low-frequency noise and infrasound were considered as eligible for the review. The exposure could be either objectively measured or based on self-reports. Studies on occupational exposure are not covered in this review.

II. A health outcome criterion. Studies should examine a range of self-reported or healthcare-registered physical/somatic neurological symptoms, well-being and discomfort indicators or diagnosed disorders.

III. A population criterion. The eligible studies recruited samples of healthy individuals being at least 15 years old. Studies on individuals with self-reported noise sensitivity were included as well.

IV. A study criterion. Only peer-reviewed articles of primary observational studies (not re-analyses, conference presentations or reviews), investigating a potential exposure-response relationship were considered as suitable for the present review. Re-analyses, reviews and population studies in which exposure was manipulated, such as “natural experiments”, were not included. Papers from conference proceedings were only included if they had undergone the peer-review process and their format was comparable to a full-length article.

2.3. Quality of information

The adequacy of the information provided in the articles was assessed based on the “Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)” statement [1]. Eligible studies should at least provide:

- Information regarding study design, sample size, recruitment and characteristics.
- A clear description of the methods that were followed for the assessment of the exposure and outcome.
- Adequate information regarding the performed statistical analyses including confounding adjustment.

If a selected article did not meet the forenamed basic criteria, further information was requested from the original authors. In case of no response, the article was excluded.

2.4. Procedure

For each included study, the following data are abstracted: references, study design, sample selection methodology, sample size, response rate, age range or mean, gender distribution, country, exposure source and levels, exposure assessment, outcome assessment, variables included as potential confounders and statistically significant exposure-outcome associations.

The literature search, evaluation of inclusion and exclusion criteria and evaluation of the quality of information in the articles were conducted by the first author, with uncertainties resolved through

consultation with the rest of the co-authors. More specifically:

- 1) In the first stage the titles and abstracts that were derived from the search process were independently screened, to evaluate whether they met the exposure and symptom criteria.
- 2) The hard copies of the publications fulfilling the inclusion criteria were assessed in terms of the population and study criteria.
- 3) The article quality evaluation was performed.

Table 1. Key search terms

Health outcome	Physical symptoms, Somatic symptoms, Health symptoms, Health problems, Health effects, Neurological symptoms, Ill health, Well-being, Quality of life, Impairment, Annoyance, Disturbance, Discomfort, Sleep quality, Sleep disturbance, Sleep problems, Insomnia, Hearing loss, Hearing impairment, Tinnitus, Vertigo, Nausea, Balance problems, Respiratory effects, Respiratory problems, Vibroacoustic disease, Stress, Irritation, Cognitive performance, Attributed symptoms, Unease, Fatigue, Aural pain, Palpitations, Cardiovascular
Exposure	Noise pollution, Environmental noise, Noise exposure, Perceived noise, Noise sensitivity, Noise susceptibility, Auditory sensitivity, Noise perception, Neighborhood noise, Infrastructure noise, Wind turbines, Compressors, Wind farms, Ventilation noise, Power lines, Transmission lines, Industrial noise, Electrical installations, Amplified music, Blasting, Pumps, Air-conditioning, Refrigerators, Fans, Boilers, Heating system, Gas pipelines, Radio sound, Radio noise, Impulse sound, Perceived sound, Transportation noise, Trains, Rail traffic, Railway vibration, Railway noise, Air traffic noise, Airport noise, Aircraft noise, Traffic noise, Road traffic noise, Cooling towers, Sewerage, Induced noise, Residential noise, Domestic noise, Low frequency noise, Low frequency sound, LF noise, Infrasound, Ambient noise, Background noise, Vibration
Design	Epidemiological, Observational, Cross-sectional, Cohort, Prospective, Case-control, population-based
Time period	January 2000 – January 2015

3. Preliminary results

Key word search from Pubmed, Embase, PsycInfo and journal databases resulted in about 4000 articles. After excluding the duplicates, these articles were screened based on title and abstract; 550 potentially eligible studies were identified, the full paper of which are currently assessed. So far, the majority of this pool of studies were either occupational or of experimental design, while a small number of studies actually measured levels of LFN. Major sources of investigation were wind turbines and road traffic noise. Results from the Scopus and Web of Science search and selection of eligible papers from conference proceedings databases is also in progress.

3.1. Data synthesis

After the final selection of eligible studies and data extraction, the included studies will be screened for meta-analysis suitability. Studies will be considered eligible if they assessed the same symptoms, or outcomes of similar meaning, employed comparable methods to assess exposure and also comparable instruments and cut-off points to assess the outcome(s). The risk of bias due to (exposure and outcome) misclassification, selective participation and confounding will also be assessed [2].

References

- [1] E. Vol Elm, D. G. Altman, M. Egger, S. J. Pocock, P. C. Gøtzsche, J. P. Vandenbroucke. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 370 (2007) 1453–57.
- [2] D. A. Grimes, K. F. Schulz. Bias and causal associations in observational research. *Lancet* 359 (2002) 248–52.