



**WHO Environmental noise guidelines
for the European Region - What is new?
2. New evidence on health effects from environmental noise and
implications for research**

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ABSTRACT

The Guidelines include systematic reviews of the scientific evidence of the critical health effects of environmental noise: effects on sleep, annoyance, cognitive impairment, cardiovascular diseases, hearing impairment and tinnitus. Other potential health outcomes with less evidence are also systematically reviewed, but have less impact on the development of recommendations: adverse birth outcomes, quality of life, mental health and wellbeing, and diabetes and metabolic diseases. The noise sources considered include aircraft, rail, road, wind turbines and leisure noise. Additionally, the Guidelines review the potential health benefits from noise mitigation and interventions to decrease noise levels.

The systematic reviews conducted for the Guidelines have revealed some key knowledge gaps and research needs, which will need to be filled in the future in order to provide stronger advice for the protection of the population from the harmful effects of noise. These gaps are related to the combined health effects of different noise sources and other environmental exposures, the lack of harmonization in the methods and metrics used to measure health outcomes and noise exposure, the paucity of longitudinal studies, and other issues related to the assessment of effectiveness of interventions for the reduction of noise exposure and improvement of health outcomes.

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1. INTRODUCTION

The WHO Guidelines for Environmental Noise, formerly Community Noise, have required updating partly because since 1999 there has been a lot of new research published on noise and health which has strengthened the evidence base and has provided new material to feed into the development of revised guidelines. New evidence has informed the development of new or revised exposure-effect relationships for health outcomes, as well as guidelines for health effects not previously considered. Some guidelines are now also informed by evidence taking co-exposure to air pollution into account. A further reason for developing updated guidelines is because the nature of noise exposure has changed, for example, with quieter vehicles but greater numbers of them.

2. METHODS

The WHO has adopted internationally recognized standards and methods for guideline development to ensure that guidelines are free from biases, meet public health needs and are consistent with the following principles: 1. Recommendations are based on a comprehensive and objective assessment of the available evidence, and 2. The process used to develop the recommendations is clear. The entire process is conducted according to the “WHO Handbook for Guidelines” (1).

The main objectives of the updated Guidelines are to systematically review the scientific literature on the health effects of environmental noise and to provide evidence-based recommendations for protecting public health from the health risks of environmental noise. In order to assess the quality of the evidence for each health outcome required for appropriate recommendations, the authors of the systematic review use the GRADE methodology which ranks the quality of evidence as high, moderate, low, or very low (2).

Environmental noise is defined in the Guidelines as “noise emitted from all sources except sources of occupational noise exposure in workplaces”. The Guidelines review all pertinent literature on health evidence, revisit the previous guidelines and issue revised recommendations, as relevant. As well, the Guidelines review the evidence on health benefits from noise mitigation and interventions to decrease noise levels. The Guidelines separately assess the environmental noise coming from different sources, for each relevant health outcome: aircraft, railway, road traffic, wind turbines, and leisure noise. The document mainly considers exposure to noise in residences, as well as hospitals, educational settings and public venues.

3. RESULTS

3.1 New evidence on health effects

New systematic reviews on effects of environmental noise from aircraft, road traffic, railways and wind turbine noise have been carried out the results of which will be reported elsewhere, including in this conference. These new reviews include a systematic review of annoyance including outcomes of annoyance scores and the percentage highly annoyed (3). The review on sleep covered exposure-response curves derived from polysomnographic data and systematic reviews and meta-analyses of self-report sleep disturbance (4). For cardiovascular disease updated evidence syntheses on hypertension, ischaemic heart disease and stroke are being prepared (5). The review on cognitive impairment included studies of reading comprehension, long-term memory, working memory and executive function, attention, and standardised achievement test data in children (7). The review of mental health included studies on common mental disorders measured by questionnaires and interviews, quality of life indices and use of psychotropic medication in adults and emotional and behavioural disorders and wellbeing in children (8). The review on adverse birth outcomes involved studies on birth weight, pre-term delivery, and incidence of congenital abnormalities (9).

In addition, a review on hearing impairment dealt with leisure noise, including from personal listening devices, and permanent hearing loss and tinnitus (6).

Finally, noise source, pathway, infrastructure, indirect interventions and behavioural change interventions were reviewed with impacts on noise reduction and benefits for health (10).

3.2 New Research needs

The development of the Environmental Noise Guidelines for the European Region has made evident some key knowledge gaps and research needs. These are discussed below:

Study design - In terms of study design there is a need for longitudinal prospective and retrospective studies. This particularly applies to studies on mental health and cognition, and hearing loss where many of the studies are cross sectional and the long-term consequences of noise exposure are unknown. There is a lack of knowledge regarding the long-term effect of acute reactions to noise events during sleep (e.g. awakenings), whose long-term effects on health should be further studied. Issues of adequate funding and cohort attrition have made longitudinal studies challenging in the past. One direction for future studies is to consider mechanism-guided studies where the impetus is to design the study to assess competing theoretical mechanisms for effects of noise on health. The role of annoyance or sleep disturbance as intervening factors between noise exposure and health are worth investigating further.

Noise exposure assessment - In recent years huge advances have been made in noise modelling. However, noise exposure assessments could be refined so as to reduce exposure misclassification. Exposure assessments, apart from just in domestic settings, are required including occupational assessment and exposure during commuting to assess total 24-hour noise exposure. The health effects of exposure to combined sources of noise are not well understood and deserve intensified research. For comparison between studies, especially in Europe, harmonisation of noise metrics is an advantage but this should not inhibit the development of innovative noise metrics, for instance taking further account of noise events and reflecting changes in traffic composition.

Populations and lifecourse approaches – It is increasingly recognised that a lifecourse approach to health is valuable. Exposure to noise and other stressors during childhood may have longer-term consequences for health. There may be critical periods for exposure to noise when children may be sensitive to noise effects and there may be impacts of cumulative exposure later in life. Retro-mapping of noise exposure may be useful here. Very early life exposure, including prenatal exposure, may lead to epigenetic changes with downstream health consequences. There have been changes in population in Europe including new migrants whose prior exposure to noise and health history may differ from the indigenous population and who require consideration in epidemiological studies. Studies using gold standard measures such as polysomnography would benefit from larger and more representative samples.

Confounding factors and effect modification – Recent investigations of noise and cardiovascular outcomes have considered a range of potential confounding factors. Air pollution has been studied as either having an independent direct effect or being a confounding factor or having a synergistic effect with noise on health. There is scope for further research to explore these effects and understand the potentially different pathways of noise and air pollution to ill-health.

Health outcomes – An increased precision and standardisation of health outcome measurement would strengthen noise studies and ease comparison between studies. Objective rather than self-report health outcomes improve study quality and confidence in study results. For instance, studies of wind turbines would benefit from objective health outcomes. Innovative methods such as ecological momentary assessments of annoyance or wellbeing should be considered. Further research on new outcomes from recent studies such as diabetes mellitus, aspects of the metabolic syndrome and cancer are warranted and may give insights into pathways from ‘stress-related’ exposures to ill-health.

Interventions – Intervention studies are an important priority for future noise research especially in studies of annoyance, cognition, mental health, and sleep. Studies should address noise interventions, noise management and noise control interventions and should be of sufficient duration to consider short and longer-term health effects as well as merely noise reduction. Standardised study protocols are needed to aid study comparability. Studies of change in noise exposure or taking advantage of natural experiments should be a priority.

CONCLUSIONS

The development of the new Environmental Noise Guidelines has continued the process of evidence review and the identification of new research directions begun with the European Network on Noise and Health (11). These exhaustive reviews are comprehensive and set a high standard for future noise effects research.

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