Proceedings of the Institute of Acoustics

ENVIRONMENTAL NOISE GUIDELINES FOR THE EUROPEAN REGION

SA Stansfeld Centre for Psychiatry, Barts and the London School of Medicine, Queen Mary University of London, London, UK

1 INTRODUCTION

The WHO Guidelines for Environmental Noise, formerly the Community Noise Guidelines[1] have required updating 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. This has allowed the development of new or revised exposure effect relationships for health outcomes, some new evidence on health effects not previously described and consideration of confounding factors such as air pollution not much explored in earlier research. A further reason for developing updated guidelines is because the nature of noise exposure has changed, particularly with quieter vehicles but greater numbers of them.

At least 100 million people in the EU are exposed to road traffic noise levels (>55dBA Leq) above those recommended in the European Noise Directive (END).[2] More than 83 million people in Europe are exposed to adverse night noise levels greater than 50dB Lnight. Thus there is a need to reduce environmental noise levels in order to improve health.

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:

Recommendations are based on a comprehensive and objective assessment of the available evidence, and the process used to develop the recommendations is clear.

Therefore, the reader will be able to see how a recommendation has been developed, by whom, and on what basis. The entire process is conducted according to the "WHO Handbook for Guidelines"[3].

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. Health outcomes deemed as critical or important by the Guideline Development Group are included in the systematic literature review using a protocol developed for this purpose. In order to assess the quality of the evidence for each health outcome required for appropriate recommendations, the authors of the systematic review used the GRADE methodology which ranks the quality of evidence as high, moderate, low, or very low.[4]

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 from various sources, for each relevant health outcome: aircraft, railway, road traffic, wind turbines, and leisure

noise. Leisure noise covers outdoor and indoor leisure noise exposure (e.g. nightclubs, pubs, fitness classes, concerts, sporting events and personal listening devices).

The document mainly considers exposure to noise in relevant settings such as residences, educational settings and public venues. Noise from construction, occupational noise, neighbour noise, combined noise sources and hospital noise are not included.

Critical health outcomes considered were Annoyance, Sleep disturbance, Cardiovascular disease and Cognitive impairment. Important health outcomes, which have lower priority because of either insufficient or mixed evidence of health effects, include Diabetes and metabolic diseases, Quality of life, mental health and wellbeing and Adverse birth outcomes.

2.1 Systematic reviews

Recent existing reviews were assessed by the Amstar checklist to assess the quality of the review. If there was no existing review a novel systematic review was developed which could be a systematic or narrative review depending on the quality of the available evidence. Timeframes of the reviews varied. A judgement of the quality of the evidence was made by the systematic review teams. Study limitations, inconsistency of results, indirectness of evidence, imprecision of effect estimates and publication bias tended to downgrade the evidence. A strong magnitude of effect plausible confounding and a dose-response gradient tended to increase the quality assessment.

2.2 Guideline exposure levels

Guideline exposure levels were derived for each noise source. The definition for the guideline exposure level was a noise exposure level above which the Guideline Development Group was confident that there was an increased risk of adverse health effects. This was developed in several stages: first, the validity of the exposure-response function for each noise source and health outcome was derived from the systematic reviews. Secondly, the lowest noise level was observed in each study. Thirdly, the smallest relevant risk increase for eight each of the adverse health outcomes was assessed. Then the guideline exposure level was derived based on the exposure-response function starting from the lowest level measured and associated with the smallest relevant risk increase of adverse health outcomes. The overall guideline level for a particular noise source was selected based on the priority health outcome with the lowest exposure level for that source. These are benchmark values not effect thresholds. Relevant risk increases were agreed on for each health outcome. For instance, for ischaemic heart disease a 5% relative risk, for increased incidence of hypertension a 10% increased risk, for those highly annoyed a 10% absolute risk increase, for those highly sleep disturbed a 3% increased risk. Disability weights were derived from the WHO Burden of disease report 2011 and from reference to earlier relevant literature.[5]

2.3 Developing the recommendations

The quality of the evidence, balance of benefits and harms, values and preferences all influenced the strength of the recommendation. A strong recommendation can be adopted as policy in most situations. The guideline is based on the confidence that the desirable adherence to the recommendation outweighs any undesirable consequences. Thus a strong recommendation should be implemented in most circumstances. A conditional recommendation requires a policy-making process with substantial debate and involvement of various stakeholders with less certainty of efficacy due to low quality evidence, opposing values and preferences, and high resource implications. This means that there may be circumstances or settings in which it will not be implemented.

3 RESULTS

Eight systematic reviews of health outcomes were carried out and one systematic review of interventions to reduce noise and in some studies to improve health. These reviews addressed two questions:

In the general population exposed to environmental noise, what is the exposure-response relationship between exposure to environmental noise (reported as various indicators) and the proportion of people with a validated measure of health outcome, when adjusted for confounders?
In the general population exposed to environmental noise, are interventions effective in reducing exposure to and/or health outcomes from environmental noise?

3.1 Transport noise

Most evidence was available for road traffic noise and health, least was available for railway noise. Aircraft noise was found to be the source causing most annoyance and sleep disturbance. Sufficient evidence was available to support the development of recommendations.

3.2 Leisure and wind turbine noise

There was very low quality evidence linking leisure noise and health; due to difficulties in properly assessing exposure and the development of tinnitus and hearing impairment. Very low quality evidence was found for wind turbine noise and health except possibly for annoyance. There were difficulties in assessing exposure from wind turbines and associations were complicated by other aspects such as amplitude modulation and visual aspects. There are new studies taking place currently that may improve the level of evidence on health effects.

3.3 Intervention studies

The systematic review on noise interventions demonstrated that most studies have been carried out for road traffic noise.[6] There was little or no evidence for interventions on rail, wind turbine or leisure noise. Most studied health outcomes were annoyance and sleep disturbance. The review showed that the effectiveness of implementations is highly context specific, also that the resources needed for implementation were highly variable and in general the great importance of involving the community in developing successful interventions.

4 RECOMMENDATIONS

Recommended exposure levels by noise source, including levels for night time exposure, are provided in Table 1. This table also includes the strength of the recommendations and the strength of the recommendations for intervening to reduce noise levels. Daytime recommendation levels are for Lden and therefore cover the 24 hour period. In summary, recommendations for all transport noise sources are strong while recommendations for leisure noise and wind turbine noise are conditional.[7]

Table 1 Recommended exposure levels

Type of noise	Strength of recommendation	Recommended exposure level	Evidence for intervening?
Road traffic day	Strong	53 dB Lden	Strong
Road traffic night	Strong	45dB Lnight	Strong
Rail traffic day	Strong	54dB Lden	Strong
Rail traffic night	Strong	44dB Lnight	Strong
Aircraft day	Strong	45dB Lden	Strong
Aircraft night	Strong	40dB Lnight	Strong
Leisure noise	Conditional	70dB Leq, 24h	Conditional
Wind turbine noise	Conditional	45dB Lden	Conditional

4.1 Research needs

Although there is convincing evidence of noise and health effects there is still a need for more longitudinal studies with objective measurement of noise exposure and health outcomes in both adults and children. It would be helpful to have an integrated analysis of the original raw data from the annoyance studies involved in the systematic review leading to a meta-analysis based on individual data. For wind turbine noise research there is a need for more methodologically robust longitudinal studies with objective measurement of both exposure levels and health outcomes. Common protocols across studies would be useful so that different studies could be compared. For leisure noise, longitudinal studies of young people using personal listening devices followed for longer periods of time would be timely to assess the risk of hearing impairment. There is a great need for more intervention studies looking at sources other than road noise and examining health outcomes beyond just annoyance. If these studies were harmonised using common protocols it would be much easier to compare results across studies.

5 REFERENCES

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