

Reviewing evidence on noise exposure and non-auditory health effects in the European Network for Noise and Health (ENNAH)

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ABSTRACT

The European Union Framework 7 (EU FP7) funded European Network for Noise and Health (ENNAH) project brings together 33 European research centers with the aim of establishing a network of experts and informing future research directions and policy needs in Europe. Part of the work activity has been to review evidence on noise and health; specifically to (i) provide a state of art summary of knowledge on noise exposure and non-auditory health effects, (ii) to identify gaps in the evidence and (iii) to make recommendations for further research.

Methods used to achieve this have been extensive database and on-line literature searches to identify published and grey literature studies, three ENNAH workshops (two specific to the literature review) and discussions with ENNAH partners.

It was decided early on not to attempt a large-scale general review of evidence as several very high quality reviews were in use or in preparation, so literature review work has centred around a review of reviews including a ranking of these using quality criteria adapted for this purpose, identification of gaps in the literature and systematic reviews in specific areas where synthesis of evidence was considered to be lacking such as noise sensitivity and health.

The dissemination plan for the literature review work has focused on making the key findings of the literature search easily accessible for the project partners. General information and the final report will be made accessible as a publicly available web document with 'click-through' facility on the ENNAH website.



INTRODUCTION

Environmental noise, caused by traffic, industrial and recreational activities is considered to be a significant local environmental problem in Europe. Noise complaints have increased in Europe since 1992 and it is estimated that roughly 20 % of the Union's population or close to 80 million people suffer from noise levels which scientists and health experts consider being unacceptable (European Commission 1996).

There is increasing evidence that environmental noise exposure has a range of impacts on health and well-being. This evidence has recently been reviewed by the World Health Organization (WHO 2011) as part of the project to estimate the burden of disease from environmental noise and to develop night noise guidelines for Europe (WHO 2009), as well as by UK governmental bodies (Health Protection Agency 2009; Berry & Flindell 2009a, b). It is well recognized that environmental noise is related to annoyance and has impacts on sleep. More recent studies suggest effects

on hypertension and cardiovascular disease and evidence for links with cognitive development in children (WHO 2009; Clark & Stansfeld 2007; Babisch 2006). One of the ways in which these effects may be mediated is via activation of the sympathetic nervous system as increases in levels of stress hormones in the blood have been measured in relation to environmental noise exposure. However, the effects on mental health are less clear – there is evidence for effects on psychological symptoms but not for clinically defined psychiatric disorders (Clark & Stansfeld 2007).

The European Network for Noise and Health (ENNAH), is a two year program funded under the EU seventh framework program environment theme that started in September 2009. It was set up to establish a research network of experts on noise and health to establish future research directions and policy needs in Europe with respect to the effects of environmental noise exposure on non-auditory health outcomes. ENNAH includes members from more than 35 institutions representing all parts of Europe including eastern member states. A key part of the ENNAH program has been a review of the existing literature on environmental noise exposure and health focusing on (i) the consolidation of existing state of the art knowledge and (ii) the identification of gaps in the evidence to identify future research needs and hypotheses to be tested.

METHODS

Scoping of the literature review

The scope and focus of the literature review was identified through a first workshop in September 2009 immediately following on from the launch meeting in September 2009 at which most of the ENNAH members were present. A combination of formal presentations from a range of experts, small group work and general discussions were used to define general principles with respect to the literature review. It was agreed that the task of identifying and reviewing all the literature again from scratch was unnecessary as there were several authoritative reviews already published or in preparation (for example: Berry & Flindell 2009a, b; Health Protection Agency 2009; WHO 2009, 2011).

The following objectives of the review were agreed:

- To summarize previous research by identifying previous reviews and authoritative studies
- To identify gaps in previous research
- To rank gaps in order of importance in terms of (a) scientific needs (b) policy-making needs
- To conduct limited literature searches in specific topics

It was decided that the review would concentrate on the above objectives and it was realized that it was unlikely that there would be scope for a quantitative meta-analysis, unless in a very specific topic area. It was considered important to consider literature not in English and this would be facilitated by the multi-national and multi-lingual membership of the network. It was agreed that the literature review would focus on health effects rather than cost-benefit analyses. Work on occupational effects of noise would need to be referred to as, although exposures are in general higher, there may be some analogy with effects expected in a population. It was noted that it might be necessary to consider literature from decades preceding the start of some

of the readily available electronic databases of scientific literature e.g. some earlier studies in the 1970s did examine aggression and noise in laboratory studies.

Attempts were made to link with networks and large groups working in the area of noise and health e.g. the ENNAH literature review workshop included a talk from Prof Jian Kang from the Acoustics group, Sheffield University about soundscape research and the COST network (<http://soundscape-cost.org/>)

A second literature review workshop was held in June 2010 to identify and explore in depth literature relevant to the research gap areas recognized in the first literature review workshop and provide recommendations for future health studies. Talks and focused discussions were held on the following topic areas identified in the first workshop: sources of noise, occupational noise, noise and co-exposures, vulnerable groups, noise characteristics, acute vs. long term effects of noise, stress and social impacts, positive effects of noise and noise reduction interventions. Following this workshop, three topics (noise annoyance and sensitivity, noise co-exposures, reproductive health effects of noise) were identified for specific substantive reviews.

Identification of existing reviews

Authoritative general reviews of the health effects of environmental noise were identified by the following means: electronic database searches, grey literature searches, emailing ENNAH WP2 workshop attendees, citation by other papers or reports for governmental bodies (e.g. Berry & Flindell 2009a, b). The reviews were grouped by topic area and ranked using a 10 point scoring system for quality.

Ranking of evidence and of gaps in evidence

Ranking of scientific evidence for some outcomes has been attempted in some of the reviews identified in the literature review work package. An attempt to rank all of the evidence and the gaps in evidence using the combined expertise of ENNAH members is in progress. At the ENNAH 'New Strategies for Noise and Health Research in Europe' workshop in February 2011, attended by many of the ENNAH participants, a brief questionnaire was used to make an initial ranking of the nature of the evidence for associations between environmental noise from aircraft, rail and traffic sources and various outcomes e.g. annoyance, cardiovascular disease etc. as sufficient limited or inconclusive or lacking. Participants were also asked to identify the three most important topics in terms of scientific needs and policy needs in noise and health research. This exercise produced a lot of discussion and will feed into a more detailed ranking exercise using web-based survey tools. The results of this are expected to help to focus future research efforts and inform policy needs.

RESULTS

Identification of existing reviews

Existing authoritative reviews were identified and abstract and weblinks were made available to ENNAH members (where permitted given copyright issues – see below), through the ENNAH website. This was indicated in a database listing (Figure 1), currently made available for ENNAH members on the ENNAH website with the intention of making this publicly available by the end of the project. The quality of each review has been indicated by color from yellow to red (where red was highest quality). It was difficult to score some grey literature reviews so these were identified in grey.

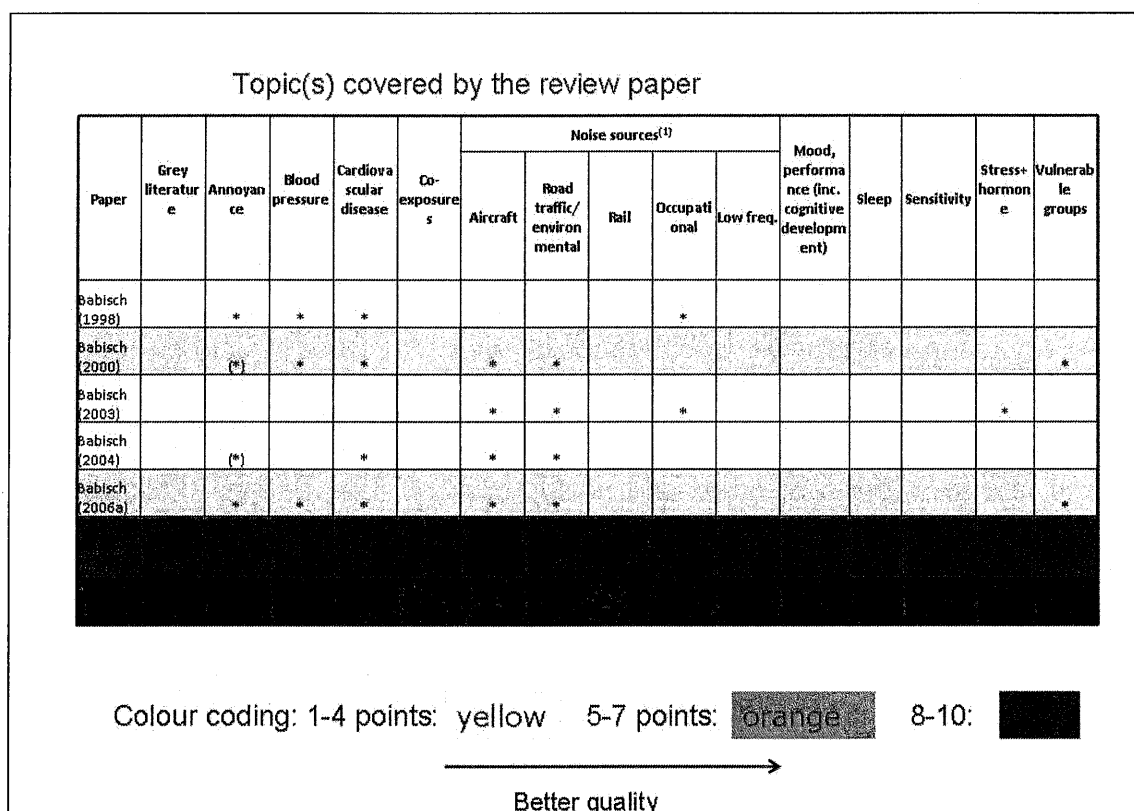


Figure 1: Screen snapshot of first page of spreadsheet of general reviews ranked by quality (except grey literature indicated by grey color)

Specific topic areas undergoing further literature review

The following areas were identified for further follow-up and are the subject of substantive reviews currently in progress:

(i) Noise co-exposures and health outcomes. This review into potential confounders and effect modifiers of noise effects is being led by Jurgita Lekaviciute and Stylianos Kephelopoulos from the European Commission Joint Research Centre, with input from ENNAH literature review work package members. Air pollution is a major co-exposure, but other exposures such as heavy metals, vibration and electromagnetic exposures may potentially confound or interact with noise effects.

(ii) Noise sensitivity and noise annoyance in relation to health outcomes. Some groups with high self-reported noise sensitivity or high levels of noise annoyance may be more vulnerable to the health effects of noise than the general population. However, very few studies have directly reported the associations between noise sensitivity or annoyance and health outcomes – studies tend to either examine noise levels in relation to noise annoyance or adjust for annoyance or sensitivity in analyses of associations between noise and health outcomes. A systematic review is in progress led by one of the authors (Helga Laszlo) with input from literature review work package members. A total of 9,160 records initially identified as possibly relevant, which has now been reduced to <100 using exclusion criteria, as most of the studies did not look at direct relationship with health outcomes.

(iii) Noise and reproductive outcomes. There is surprisingly little information about associations between environmental noise and reproductive outcomes. If the stress

mechanism is important in mediating health effects of environmental noise such as hypertension and cardiovascular disease risk, then environmental noise might also have impacts on reproductive health including birth weight. A systematic review is underway, being led by Dr Gordana Ristovska of the Institute of public health of the Republic of Macedonia.

Further issues identified as gaps in the literature

It was noted that the main health outcomes studied to date have been cardiovascular health, mental health and psychological/psychiatric health. Health outcomes not or poorly studied to date e.g. respiratory health, developmental effects including birth outcomes (birth weight, miscarriages), stress mediators (cortisol, insulin resistance, abdominal obesity, blood lipids), sleep disturbance in infants, immune system dysfunction, and general health status. The following additional research gaps were identified:

- Cognitive effects of noise
- Recreational noise e.g. personal stereo devices
- Multiple sources of noise
- Acute vs. chronic effects of noise
- Effects of low frequency noise
- Noise effects on the metabolic system
- New sources of noise such as wind farms
- Observed health benefits (if any) of noise reduction schemes
- Interventional studies of noise reduction
- Positive effects of noise and positive soundscaping.

It was also recognized that there are many uncertainties related to exposure estimation, including choice and implementation of noise models, variability in noise measuring devices (if measurements are used), within-house variability in differences between outdoor and indoor sound levels, effects of opening windows, impact of sound insulation, lack of information on personal exposures (occupational exposures, personal stereo devices, community noise and protective factors e.g. deafness), impact of distance from source, average noise levels vs. noise events above a certain noise threshold, habituation effects etc.

Copyright issues

Copyright issues affect the dissemination of the results of the literature search. Because of copyright issues, many of the identified studies on noise and health could not be freely circulated in full among the partners nor published on the ENNAH website for the general public. Additionally, the 33 ENNAH partners were from different institutes with different licenses to download and print papers. According to copyright law, redistributing the articles on PubMed central needs the permission of the copyright holder, except for PMC articles in the open access subset. Even the circulation of journals with 'free access' documents depend on the open access agreement associated with the article (e.g. a creative commons license). Circulating a copy on behalf of the author is not allowed, unless circulating a copy to peers is included in the copyright transfer agreement. Web reports such as those from the WHO and (UK) Health Protection Agency are often subject to copyright where, although reports are free to download, permission must be sought for non-commercial redistribution so

only links can be provided. As a result, the work packages were only able to provide a publications list, the citation and a link to the publication on the publisher's website but not the full article. Access to the full-text was available to those with permitted access via their institutions or personal journal subscriptions.

CONCLUSION

The ENNAH project literature review work package has attempted to identify all major current general and cause-specific reviews on health effects of environmental noise and to rank these according to quality. This information is currently available on the ENNAH website to members and will be made publicly available by the end of the project in August 2011. While there have been a number of substantive reviews of the health effects of environmental noise, including most recently the WHO publication 'Burden of disease from environmental noise' (WHO 2011), most of the research in this field to date has focused on cardiovascular disease, cognitive impairment in children, noise annoyance and sleep disturbance. A number of important gaps in the literature have been identified, including questions about exposure assessment and co-exposures, lack of information on health effects of noise mitigation measures or potential benefits of soundscaping and poorly studied outcomes such as reproductive health outcomes and respiratory disease. Substantive reviews by ENNAH members are now underway with respect to co-exposures including air pollution, reproductive health and noise sensitivity. Finally, the literature review work package has been involved in attempting to rank the gaps in terms of evidence and policy needs, to help direct future research in this field.

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