Systematic review of evidence on the effect of environmental noise on quality of life, wellbeing and mental health

Charlotte CLARK1; Katarina PAUNOVIC2
1 Queen Mary University of London, United Kingdom
2 University of Belgrade, Serbia

ABSTRACT
This paper reports the findings of a review of the evidence for an effect of environmental noise on mental health, wellbeing and quality of life, carried out for the World Health Organisation Europe. Using a systematic review methodology, quantitative non-experimental studies of the effect of environmental noise exposure on child and adult mental health, wellbeing and quality of life published between January 2005 and October 2015 were sought from citation databases. These papers were added to papers published up to 2005, identified by a previous systematic review. A total of 29 papers were identified. 83% of the papers were of cross-sectional design, with fewer longitudinal studies and very few studies of interventions. 66% were of adult populations and 34% were of child populations. The most commonly reported outcomes were self-reported quality of life using established scales (55%), emotional and conduct disorders in children (31%), and hyperactivity symptoms in children (17%). Outcomes more indicative of psychiatric health were less reported, with 10% reporting medication use, 14% reporting self-report of anxiety or depressive symptoms, and 7% reporting interview measures of depressive and anxiety disorders. The majority of papers examined road traffic noise exposure (83%). Robust studies of large samples remain a priority.

Keywords: Noise and health I-INCE Classification of Subjects Number(s): 62.5

1. INTRODUCTION
The World Health Organisation Guidelines for Community Noise have been influential since their first publication in 2000 (1) and are currently in the process of being updated by the World Health Organisation Europe (WHO Europe). To inform this process, the WHO Europe commissioned a systematic review of the scientific evidence for environmental noise effects on quality of life, mental health and wellbeing.

2. METHOD
2.1 Scope of the Review
Initially, a search for existing systematic reviews was conducted. Five existing systematic reviews of the effects of wind-turbine noise on quality of life, mental health and wellbeing were identified: the findings of these reviews were synthesized separately and the results reported elsewhere (2). This paper reports only on the findings for environmental noise exposure, excluding wind-turbine noise.

The initial search identified one existing systematic review that drew conclusions about the strength of the evidence for environmental noise effects on child and adult mental health (3). Therefore, a new search for primary papers was conducted from 2005 onwards to build on this existing systematic review. The review sought to identify original research papers of quantitative design, on the effect of environmental noise on mental health, wellbeing and quality of life published up to October 2015. Search terms covering different sources of environmental noise (aircraft, road

1 c.clark@qmul.ac.uk
2 paunkaya@yahoo.com
traffic, railway), different study designs (cross-sectional, longitudinal), and different outcomes (quality of life; self-reported depression, anxiety & psychological symptoms; medication use; interview measures of depressive and anxiety disorders; emotional and conduct disorders in children, hyperactivity) were included in database searches of Medline/Pubmed; Scopus (includes Embase); PsycInfo, Web of Science Database and ScienceDirect. See Table 1 for the complete list of search terms included.

2.2 Search Strategy
Quantitative papers in all languages were sought but due to time constraints, conference proceedings were not additionally searched. The reference lists of identified papers were also checked for further relevant citations. Grey-literature, already known to the authors was also included in the review.

2.3 Review Process
Papers were reviewed in two stages. First, all the titles and abstracts of the identified papers were reviewed by two reviewers (CC, NS) separately to assess eligibility for inclusion in the review. Second, the full text of eligible papers was retrieved and two reviewers (CC, KP) read the paper and re-assessed eligibility for inclusion. At both stages, where there was disagreement between the reviewers discussion was held until consensus reached.

<table>
<thead>
<tr>
<th>Table 1: - Search terms for the review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>Environmental noise</td>
</tr>
<tr>
<td>Study design</td>
</tr>
<tr>
<td>Quality of life, mental health or wellbeing outcome</td>
</tr>
</tbody>
</table>
Health Survey (SF-36), General Health Questionnaire (GHQ), WHO Quality of Life assessment (WHOQOL and WHOQOL-BREF), Health-related Quality of Life (HRQOL); medication intake for treatment of anxiety and depression; self-reported depression, anxiety and psychological symptoms (scale); interview measures of depressive and anxiety disorders; hospital admission data for psychiatric disorders; emotional and conduct disorders in children (e.g. assessed by instruments such as strengths and difficulties questionnaire and KINDL); helplessness; behavioural/behavioral issues

2.4 Data Extraction

Data extraction was undertaken by both reviewers (CC, KP) identifying key features of the study including, design (e.g. cross-sectional, longitudinal), population/setting (e.g. children or adults/ home or school), exposure (source, range of exposure, comparison groups), confounding (factors analyses adjusted for), outcome examined (e.g. which measure to assess quality of life, mental health or wellbeing), findings (estimated effect per 1dB increase in exposure, where possible). Again, data extraction tables were compared across the two reviewers and discussed where there was disagreement until consensus was reached.

Each paper was assessed for the following types of bias:

1. Study design: cohort, case-control, or cross-sectional, with the former being less biased than the latter.
2. Noise exposure assessment leading to information bias: evaluating whether the paper uses established noise metrics in dB; the time-frame of noise measurements, if applicable; quality of noise modelling, if applicable.
3. Bias due to confounding: evaluating whether the study used matching or adjustment in the analysis for potential confounding factors, such as socioeconomic status, which can influence noise exposure and quality of life or mental health or wellbeing.
4. Bias due to selection of participants: whether participants are randomly sampled from a known population and a response rate higher than 60%.
5. Outcome assessment leading to bias: assessment of whether the outcome of interest is objectively measured and assessed using a known scale or validated assessment method.

Bias was also considered present for each aspect noted above, if this information was omitted from the paper.

2.5 Evaluating the Strength of the Evidence

The study design and methods used within each domain varied widely in terms of noise exposure (and how defined) and in terms of which assessment of quality of life or mental health or wellbeing had been employed and how effects had been estimated. For these reasons, this is a narrative systematic review, rather than a systematic review including meta-analyses. Unfortunately, the studies are not uniform in how they define exposure or in how they measure specific outcomes to enable meta-analyses within each domain.
In order to assess the quality of the evidence for each health outcome required for appropriate recommendations, we used the GRADE methodology which ranks the quality of evidence as high, moderate, low, or very low (4). This review adapted the GRADE methodology, which traditionally assigns high quality evidence only to evidence from studies of a randomized control study design: this is inappropriate for this field where the authors felt that studies of a longitudinal design should be assigned the highest quality of evidence available.

3. RESULTS

3.1 Papers Identified

In total, 730 citations were identified from a search of the databases, but there was a degree of overlap in citation identification between the databases. Screening of the citations identified 63 that were potentially relevant, of which 18 were duplicates, 24 were included and 21 were excluded after full text retrieval, mainly because they did not measure noise exposure or a relevant outcome, were review papers, or were experimental studies.

Following this systematic process of searching for papers, five additional papers were added. The reviewers and the Guideline Development Group identified these papers: most of the additional papers identified were published in mid-2015 onwards.

This led to a grand total of 29 primary research papers for inclusion in the systematic review: 24 identified from the systematic database search and 5 identified from our search of additional papers (see Figure 1).

3.2 Summary of Papers

The majority of the studies were of cross-sectional design (83%); there were far fewer studies of more robust quantitative design such as longitudinal studies (17%) and intervention studies (3%). One-third of the studies were of child populations (34%) and two-thirds were of adult populations (66%).

Most studies examined road traffic noise exposure (83%) or aircraft noise exposure (41%). Two-thirds of the papers used the Leq noise metric (66%). Only five studies examined railway noise and three studies examined co-exposure with air pollution. Most papers focused on the home environment (93%), but one-third also considered school exposure (31%).

A range of mental health and wellbeing outcomes had been examined. The most commonly reported were self-reported quality of life (wellbeing, health status, vitality) using validated well-established scales (55%) such as the Short Form Health Survey (SF-36) and the General Health Questionnaire: however, the scales employed across these studies varied, making comparison across studies challenging. Nine papers (31%) considered emotional and conduct disorders in children usually measured with the Strengths and Difficulties questionnaire: a further five papers (17%) examined hyperactivity symptoms in children. Outcomes more indicative of psychiatric health were less reported, with 10% of papers reporting on medication use, 14% reporting self-report of anxiety or depression symptoms, and 7% reporting interview measures of depressive and anxiety disorders. Most of the studies took adequate account of sociodemographic confounding between noise exposure and quality of life, mental health and wellbeing.
3.3 Strength of the Evidence

This paper will present an evaluation of the strength of the evidence for environmental noise effects on the following domains:
1. Self-reported quality of life
2. Medication intake for the treatment of anxiety and depression
3. Interview measures of depressive and anxiety disorders
4. Emotional and conduct disorders in children
5. Hyperactivity

We will review the evidence in terms of the number of studies in the field; findings for different noise sources; the consistency of findings across studies; the study design (e.g. whether there is longitudinal evidence or intervention evidence); whether there is evidence for exposure-effect relationships between noise exposure and the outcome; and the presence of bias in the available
4. DISCUSSION

The conclusions of this review regarding the strength of the evidence for environmental noise effects on quality of life, mental health and wellbeing will be used by the World Health Organisation Europe’s Guideline Development Group (GDG) to inform revised guidelines for environmental noise exposure. The current guidelines (5) suggest that within the home environment background sound pressure should not exceed 50 dB $L_{A_{eq}}$, 16 hours in outdoor living areas in the day-time and evening and that levels should not exceed 30 dB $L_{A_{eq}}$, 8 hours outside bedrooms.

Preliminary conclusions from this review suggest a lack of longitudinal and intervention studies across most outcomes, and a lack of studies examining exposure-effect relationships. We need methodologically robust longitudinal studies of large samples. Standardised measures of quality of life and mental health, including psychiatric symptoms/diagnoses should be included. Studies should assess sub-group differences in effects for vulnerable groups such as children, the elderly, those with existing poor physical and mental health. Many of the studies of environmental noise effects on quality of life, wellbeing and mental health do not take into account an individual’s history of mental ill-health, their ability to cope, their annoyance responses or their appraisal of the noise (6). These may be important confounding factors in the association and current studies may be over-simplifying the relationship between environmental noise and mental health.

The papers identified almost all focus on using noise metrics based on average sound pressure levels over a given period of time, such as the day-time or night-time period. There is debate within the field as to about whether aggregated noise measures such as these $L_{A_{eq}}$ measures best represent how human’s respond to noise and about how best to conceptualise the ‘dose’ of exposure in community studies of noise exposure. Other noise metrics need to be explored in relation to quality of life and mental health outcomes.

A major limitation to this systematic review is the lack of homogeneity of methods and reporting between the studies, which has meant that it has not been possible to conduct meta-analyses across the studies. Such meta-analyses would enable the effect across studies to be estimated, which would inform uncertainty relating to the study findings. Unfortunately, this is not yet possible for several reasons. Combining estimates across studies that use different assessments is challenging and often not possible. Further, many studies group exposure into high and low, using different thresholds for high and low, which again makes combining study data challenging as the range of noise exposure within the high and low categories is unknown and cannot be estimated reliably from the data provided. The potential to be able to conduct meta-analyses within this field will be greatly enhanced if future studies report effect estimates for a 1dB and 5dB increment in noise exposure and if studies report the range of noise exposure in their population even if their design involves selecting samples based on high and low noise exposure.

ACKNOWLEDGEMENTS

The authors acknowledge the support of the WHO Europe Guideline Development Group and would also like to thank Mel Smuk and Neil Smith from Queen Mary University of London.

REFERENCES


