DOI: 10.61782/fa.2025.0559

FORUM ACUSTICUM EURONOISE 2025

Meta-analyses in noise and health: to update or not?

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ABSTRACT

The Interdepartmental Group on Costs and Benefits noise subject group (IGCB(N)), a UK Department for Environment, Food and Rural Affairs (Defra) led group, has been asked to prepare written guidance on the evidence base to determine whether updates to their previous recommendations are advisable. An important aspect of these recommendations are exposure-response relationships between transportation noise and health outcomes. The Dutch National Institute for Public Health and the Environment (RIVM) was asked to determine whether the existing exposure-response relationships (developed for the WHO Guidelines on Environmental Noise) between transportation noise and stroke or diabetes, derived from meta-analyses, need to be updated, and if so, to provide an update. Meta-analyses are an important method to derive exposure-response relationships. But carrying out a(n update of a) meta-analysis can be time-consuming. There can be different scientific, statistical and policy-related reasons for updating a meta-analysis. Currently there is no framework available that can be used to decide whether an update of a meta-analysis is needed. During the conference we present a proposal for a framework which could help in deciding whether or not to update meta-analyses and apply this to the case of noise and stroke.

Keywords: Exposure-response relationships, meta-analysis, transportation noise, stroke.

1. INTRODUCTION

The Interdepartmental Group on Costs and Benefits noise subject group (IGCB(N)) has been asked to prepare written guidance on the evidence base to determine whether updates are advisable to their previous recommendations for estimating and evaluating the impacts of environmental noise on the population in terms of monetary value. An important aspect of these recommendations are exposure-response (ER) relationships between transportation noise and health outcomes. The IGCB(N) has asked the Dutch National Institute for Public Health and the Environment (RIVM) to determine whether the existing ER-relationships derived in the systematic review of Van Kempen et al. (2018) [1] for stroke and diabetes needs to be updated and if so, to provide an update. The IGCB(N) will use the output from this study as part of the evidence base to determine whether updates to their existing recommendations are advisable.

1.1 Exposure-response relationships and meta-analyses

ER-relationships describe the relationship between the level of exposure (or dose) and the degree of effect. Effects can be represented in several ways. E.g., by its severity or by the probability of its occurrence (often referred to as response) [2]. ER-relationships can be used (i) to estimate the number of people that are affected (as part of a health-impact assessment), (ii) for deriving limits or guideline values, or (iii) to inform the public and raise further (political) awareness.

An important method of deriving ER-relationships in environmental epidemiology is combining the results of different individual studies by means of a meta-analysis [3]. Meta-analyses (often part of systematic reviews) are an indispensable component in the chain of scientific information [4]. The aim is often to provide a more precise

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estimate of the impact of an exposure (or other risk factor) and to reduce uncertainty [5]. However, carrying out a meta-analysis can be time-consuming [6]. The same is true for an update of a meta-analysis. When is the best time to perform an update of a meta-analysis? Meta-analyses are often updated simply because new primary studies are published. Or because new studies have fewer limitations, such as employing more robust analytical techniques accounting for additional confounders or having better methodological quality. Newly identified studies may or may not change the conclusion of a previously performed meta-analysis, depending on various factors. What if the estimates are approximately the same in the newly published studies, is it useful to perform an update of a meta-analysis?

Although several organizations (e.g., the Agency for Healthcare Research and Quality (AHRQ)) have presented criteria and/or tools that can help researchers to decide whether an update of an existing systematic review and/or meta-analysis is needed, a golden standard is not yet available [6]. For example, on her website, Cochrane advises the use of a tool developed by Garner et al [6, 7]. However, like most of these tools, Garners' tool is also designed for clinical trials. But does this work in the field of environmental epidemiology and more specifically in the field of noise and health? Recently, a few umbrella reviews have been conducted in the field of noise and health (e.g., [8-10]) which use the AMSTAR-checklist [11] and some additional criteria to decide on an update. However, AMSTAR focuses on evaluating the quality of systematic reviews and does not offer a framework for determining whether or not an update is needed.

1.2 The case: transportation noise and stroke

This paper focusses on the impact of noise on stroke. The starting point is the evidence review of Van Kempen et al. (2018) dealing with cardiometabolic effects of noise [1]. It was commissioned by the World Health Organization (WHO), and formed, together with other evidence reviews on the health effects of noise, important input for the Environmental Noise Guidelines for the European Region [12]. As part of their review, Van Kempen et al (2017) were able to evaluate nine observational studies that investigated the impact of transportation noise on the likelihood of stroke. These studies were published up to October 2014. However, after this date, several new studies including new results have been published, and existing studies have published extra or updated results. In addition to new results, there are also indications that the quality of studies have been improved. Since the publication of Van Kempen et al (2018), the results of more cohort studies dealing with the impact of noise on stroke, have become available. In comparison with the existing studies, the exposure assessment seems to have been improved and researchers were able to adjust for additional relevant confounding factors. Since the publication of Van Kempen et al. (2018), several meta-analyses on the association between exposure to transportation noise and the risk on stroke have also been published. So, one could wonder whether the estimates derived by Van Kempen et al., (2018) are still valid, and if not, what would be the best available estimate presented in the other meta-analyses. Or is it better to produce an update? And if so, do the results of newly published study results lead to different effect estimates, and do they improve the quality of the existing evidence?

1.3 Aim

Due to a lack of an existing standard, we developed a framework that could be used to decide upon an update of a meta-analysis. A pre-requisite is that there is an existing systematic review including one or more meta-analyses, with a clear and preferably narrow research question. For the purpose of this paper we will focus on the impact of transportation noise on stroke. More specifically we are focusing on the following research question: *"In the general population exposed to environmental noise, what is the exposure-response relationship between exposure to noise from road traffic, rail traffic or air traffic and the proportion of persons with a validated measure of stroke, when adjusted for main confounders?"* A possible update needs to answer this specific research question, using explicit systematic methods. Furthermore, the update should include a quantitative combination of findings through meta-analysis in order to provide a summary estimate.

2. METHODS

2.1 The framework

The developed framework is a combination of guidelines presented by Kim et al (2022), supplemented with suggestions from Garner et al (2016) [6, 13]. A proposal of the framework was presented and discussed during an

international workshop held in October 2024. Participants of the workshop were experts in the field of noise and health, air pollution and health, experts working at the Dutch Cochrane Collaboration, and policy makers. The results of the workshop were used to improve the framework. There is insufficient space here to delve deeply into the outcomes of the workshop. However, several key takeaways emerged: many participants emphasized the significance of the improved quality in newly published studies. Furthermore, the decision to update or not is influenced not only by time and budgetary constraints but also by the intended purpose, i.e. whether to inform policy or improve scientific understanding. In addition, the need for future-proofing the reviews was discussed through for instance a so-called living review.

In its current form, the framework considers the following elements:

1) The availability of additional relevant systematic reviews including one or more meta-analyses published after the existing systematic review (including meta-analysis) for which an update needs to be determined.
2) Determining the quality of the identified additional relevant systematic reviews, and
3) the methodological quality of the meta-analyses described in the identified additional relevant systematic reviews;
4) The currency of the information presented. This refers to how up-to-date the information is that was presented in the identified relevant systematic reviews published after the existing systematic review (including meta-analysis) for which an update needs to be determined.
5) The discordance or discrepancy between the results of the additionally identified relevant systematic reviews and the existing systematic review (including meta-analysis).
6) The likeliness that the findings and/or credibility of the existing systematic review (including meta-analysis) or the identified relevant systematic reviews change after inclusion of other/new evidence or information.

2.2 Identification of additional and/or new relevant systematic reviews

The starting point is the systematic review including the meta-analyses on the impact of road, rail and air traffic noise on stroke, by Van Kempen et al. (2018). To determine the availability of additional and/or new relevant systematic reviews including one or more meta-analyses, published after Van Kempen et al. (2018), reporting on the possible impact of noise from road, rail or air traffic noise on stroke, we made use of the results of searches of four reviews that were carried out after the publication of Van Kempen et al (2018): Van Kamp et al (2020), Persson Waye & Van Kempen (2021), Van Kempen & Reedijk (2023), and Van Kempen & Persson Waye (2023) [14-17]. These four reviews have applied the same search profile and study selection criteria as Van Kempen et al (2018). Together, they gave a good overview of the study material that has become available up to January 2023. To be as up-to-date as possible, we carried out an extra search for the period October 2022 - May 2024. To this end, we applied the search profiles as used in Van Kempen et al (2018). The 6 databases were used to identify relevant systematic reviews and meta-analyses.

The systematic reviews had to answer the following research question (formulated in accordance with PECO): “In the general population exposed to environmental noise, what is the exposure-response relationship between exposure to noise from road traffic, rail traffic or air traffic and the proportion of persons with a validated measure of stroke, when adjusted for main confounders?” In practice, this means the following:

Within the studies, noise exposure sources of interest were road, rail and air traffic. Noise from other sources such as wind turbines and/or industry will not be considered in this project.

The health outcome of interest was stroke (cerebrovascular accident) (ICD-10: I61-I64). Stroke belongs to the group of so-called cerebrovascular diseases (ICD-10: I61-I69). Cerebrovascular diseases are an umbrella term for conditions that impact the blood vessels in the brain. Examples of other cerebrovascular diseases are cerebral aneurysm or cerebral ischemia. For this project we focus on cerebrovascular diseases with ICD-10 code: I61-I64. However, since the above-described search was designed to identify studies investigating the impact on cerebrovascular disease, it also revealed studies looking at the impact of noise on cerebrovascular disease (ICD-10: I65-I69). For now, we decided to keep these studies apart, for future sensitivity analyses.

People can be exposed to noise in a lot of settings. For this project, only exposure in the residential setting (at home) is relevant. Exposure to noise in other settings such as exposure at work (occupational setting) or exposure at school (educational setting) are not considered.

Preferably, systematic reviews and meta-analyses should consider so-called "high-quality studies". Frameworks such as GRADE [18] consider randomized clinical trials as the highest level of quality of evidence. Since it is not very ethical to carry out a clinical trial to investigate the impact of environmental exposures such as noise, observational studies are often the highest quality level of evidence that is available. Similar to Van Kempen et al. (2018) we consider studies that investigated the impact of noise exposure on stroke by means of cohort and/or case control studies (usually dealing with incidence and/or mortality) in principle as high quality studies. Of course, we realize that there may be several factors that decrease the quality of a study (the way exposure was assessed, ascertainment of the outcome, the possibility to adjust for potential confounders, etc.). In accordance with what was studied by Van Kempen et al. (2018), and to get an overview as complete as possible, systematic reviews (including meta-analysis) dealing with the impact on the prevalence of stroke, often investigated in cross-sectional studies, were also considered as relevant for the current project. Cross-sectional study designs are considered as less superior to cohort or case-control designs. Therefore, we realize that cross-sectional studies (often investigating the prevalence) and meta-analyses including cross-sectional studies will not improve the quality of the evidence substantially.

2.3 Determining the quality of the identified additional relevant systematic reviews and the included meta-analyses

After identifying relevant systematic reviews that include one or more meta-analyses, their methodological quality was assessed by means of parts of the AMSTAR-2 checklist [11]. For this project we focussed on the following items: 2, 4, 7, 9, 11, 13 and 15. By means of item 11 of the AMSTAR-2 checklist a first evaluation of the quality of the meta-analysis was done, by evaluating the appropriateness of the methods for statistical combination of results. In addition, we made use of item 37 of the quality assessment tool for meta-analyses presented by Higgins et al. (2013) [19].

3. PRELIMINARY RESULTS

3.1 Identified and selected relevant systematic reviews

To find out whether since the publication of Van Kempen et al. (2018), other systematic reviews including meta-analysis were published in the scientific literature, we created a database from the searches that were completed for the four reviews described in the method-section and Van Kempen et al (2018). This revealed a database of 1.515 references including 2 retractions. In May 2024, an additional search was carried out covering the period October 2022 – May 2024. By means of this search we were able to identify another 137 unique references. In addition, we found 4 additional references that were not available via the described searches, but via hand search in conference proceedings in the area of noise and health. Adding these 141 references to the database, revealed a database of 1.656 references including two retractions. The database appeared to have 9 relevant systematic reviews including several meta-analyses dealing with the impact of transportation noise on stroke [1, 10, 20-26].

3.2 Quality of the identified and selected systematic reviews and meta-analyses.

It appeared that four [20, 21, 25-27] of the nine reviews registered their protocol before commencement. In all studies, at least two literature databases were searched to identify potentially relevant studies. Apart from Dzhambov [26], all reviews reported both (i) the search profiles that were used to identify potentially relevant studies, and (ii) the in- and exclusion criteria that were being used to select relevant studies. Across the nine reviews, seven different instruments were used to assess the individual study quality. E.g. Newcastle Ottawa Scale, Robins-E tool, the Navigation Guide developed by the WHO and the International Labour Organization, or an adjusted version of CASP and SIGN. In five reviews [1, 10, 21, 22, 24, 27] the overall quality of the available evidence was assessed. In each case, the researchers used the GRADE-tool or an adapted version of this tool.

Table 1 shows a first overview of the quality of the meta-analyses that were included in the identified and selected systematic reviews. We were not able to evaluate how Leduc et al identified sources of heterogeneity, the techniques they used to combine results of different studies and or to identify reporting bias and possible double counting, since the results of Leduc were not available in a paper or report.

Table 1. Quality of the identified and selected meta-analyses

Reference of the review	Hetero geneity[a]	Meta-analysis technique[b]	Repor ting bias[c]	Double counting
[1]	ABCD	C	AB	No
[26]	ABCE	B	CD	No
[25]	ABD	C	NR	No
[24]	ABCDE	BC	CD	Probably not
[23]	ABDE	AC	B	Probably yes
[22]	ABCD	A	B	Yes
[21]	Unclear	Unclear	Unclear	Unclear
[20]	ABCDE	AC	AB	Probably
[10]	ABC	C	NR	Probably

a)Identification of sources of heterogeneity: A = by means of visualization (e.g. forest plots), B = I2 statistic, C = Cochran's Q-test, D = by means of subgroup analyses, E = by means of sensitivity or leave-one out analyses. b) Techniques used to combine the results of different studies: A = Fixed effects model, B = IV-het model, C = Random effects model, NR = Not reported; c) Techniques used to identify reporting bias: A = funnel plot(s), B = Egger's test of publication bias, C = Doi-plot, D = Luis Furuya-Kanamori Index, NR = Not reported

4. DISCUSSION AND CONCLUSIONS

When drafting this paper, the project is still running. Consequently, we are only able to present some first descriptive results in this paper.

To further determine whether an update of the meta-analysis of the existing meta-analysis dealing with the association between transportation noise exposure and stroke is needed, we will firstly evaluate the information presented in the identified and selected systematic reviews and meta-analyses: how current is the information included and is there any discrepancy between the results of the different systematic reviews? A systematic review and its' meta-analysis are considered as up to date ("current") when: a) there is no new evidence, and/or b) even though there is new information (including other methods), it is unlikely that this will change the review conclusions. To determine the currency, we will check what part of the existing evidence was covered by the systematic review and its' meta-analysis, or in other words: to what extent did the reviews miss relevant evidence, and what was the quality of this missing evidence. To this end, we will use information from all the studies that were published until May 2024, and compare this with the studies included in the identified relevant systematic reviews.

If more systematic reviews try to answer the same research question, discrepancy ("discordance") can arise with regard to the results they present and the interpretation of the presented results. To determine whether the results of the identified additional reviews are discordant, we will compare several aspects such as the research question, the included studies (including their selection criteria), the results of the meta-analyses and the quality of the included studies.

Secondly, we will try to give insight as to whether and how the results and their credibility change after inclusion of new evidence (new studies) or other relevant information. If it is clear that an existing systematic review and meta-analysis is missing information, we need to find out how likely it is that the results and/or credibility change after inclusion of the missing information. To get a feeling of the likeliness that findings and/or credibility of systematic reviews and its' meta-analysis change after inclusion of other or new evidence/information, we will evaluate how many studies with what quality were already included in the existing review(s), and which studies with what quality were not yet included.

During the conference, we will present our framework, and present the results of the remaining steps required according to our framework in order to determine whether an update of the existing meta-analysis dealing with the association between transportation noise and stroke is needed. If, based on our framework, it appears that an update of the most recent and best available meta-analysis, is useful and necessary, we will proceed accordingly and present these findings also at the conference. And of course, we welcome feedback from conference attendees on the framework. If agreement on the content can be obtained, we would welcome views on whether the framework should be standardized.

5. ACKNOWLEDGMENTS

This project was funded by the Interdepartmental Group on Costs and Benefits noise subject group (IGCB(N)) of DEFRA of the United Kingdom. The international workshop that was held in October 2024 for the development of the framework was funded by a grant from the Dutch Ministry of Education, Culture and Science

(OCW). We would like to thank all participants for their valuable input during this workshop.

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