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Occupational exposure to noise in the extractive industry and earthworks – a systematic review protocol

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Abstract

Occupational noise-induced hearing loss (ONIHL) is one of the most recognised occupational diseases globally. Mining and earthworks are among those with the greatest impact in this matter. A systematic review addressing the noise exposure characterisation, in order to develop a preventive design, is being proposed in this protocol. The Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) guidelines were used to draw the research outline, where the study and report characteristics are provided. All of the selected keywords and databases/journals were priorly identified and are presented. The search methodology is clarified, and an example for Scopus database is provided. A methodology to deal with bias within studies is proposed, and all the systematic review narrative processes are discussed in the protocol, including information that will be extracted from the selected records. The Preferred Reporting Items for Systematic Review and Meta-analysis guidelines will be used to help develop the review.

1. INTRODUCTION

Noise-induced hearing loss (NIHL), the irreversible damage caused to the auditory nerve (or its components) which begins in the range between 3000-6000 Hz (Kanji, Khoza-Shangase, & Ntlhakana, 2019), occurs after a prolonged period of exposure to high levels of noise (Golmohammadi & Darvishi, 2020). NIHL can be divided into two types: a temporary threshold shift, which results in temporary loss of hearing or, in most cases, a permanent threshold shift which affects the worker's ability to hear soft sounds (Alfaro Degan, Coltrinari, Lippiello, Nataletti, & Annesi, 2019). It is thought that, globally, NIHL contributes up to 16% of adult hearing loss (Alfaro Degan et al., 2019).

Occupational noise-induced hearing loss (ONIHL) in one of the most well-known diseases resulting from the occupational noise exposure, in particular at intensities of 85 dB or higher (Kanji et al., 2019; Moroe, Khoza-Shangase, Kanji, & Ntlhakana, 2018). In the United States (US) alone, 18% of workers presented hearing loss, where the industries with higher prevalence were mining, wood product manufacturing, and construction of buildings (Masterson et al., 2013).

Some of the nefarious effects of noise exposure include sleep disturbance, speech interference (Dzhambov & Dimitrova, 2017; Golmohammadi & Darvishi, 2020), cardiovascular effects

(Skogstad et al., 2016; Yang et al., 2018), and hypertension (Bolm-Audorff et al., 2020). The impact of noise in several systems such as respiratory, immune, gastrointestinal reproductive and neurogenic has also been addressed in several studies pointed out by Yang et al. (2018). A negative impact on worker's cognitive performance was also found in the literature (Dzhambov & Dimitrova, 2017). There is a systematic review analysing risk factors that can worsen noise-induced health effects, dividing them into four groups: 1) personal factors - ageing, and smoking, 2) physical agents - vibration, and heat, 3) chemical agents - chemicals, solvents, carbon monoxide, and metals and 4) occupational factors - shift work (Golmohammadi & Darvishi, 2020). This set of factors may also indicate that combined exposure to noise and other factors can potentiate its adverse effects; however, further studies are still needed.

According to the USA National Institute for Occupational Safety and Health (NIOSH), four out of five mining workers have a hearing impairment when reach retirement age[1]. These data are in line with other studies that show that approximately 73.2% of miners are exposed to excessive noise (Moroe et al., 2018). Lawson et al. (2019) refer in their work that a number of studies have presented results indicating that within mining and quarrying sectors, there is a high prevalence of hearing loss.

In the exploitation cycle, noise exposure comes from activities such as extraction, transport and crushing, where all equipment is considered a noise source (Akinluyi, Aworian, Oladejo, & Ogunniyi, 2019; Alfaro Degan et al., 2019; Kanji et al., 2019). Studies also showed that trucks and bulldozers could produce noise levels of 114 dB and 110 dB, respectively (Lilic, Cvjetic, Knezevic, Milisavljevic, & Pantelic, 2018). Every other equipment, with the exception of the belt conveyor, are above the maximum recommended exposure of 87 dB (European Parliament, 2003). Another study measured excessive noise levels in three different settings: plant processing (94 dB), underground mining (102 dB) and underground workshop (103 dB), once again, values above the recommended exposure (Chadambuka, Mususa, & Muteti, 2013).

In the construction field (excavation and earthworks), whenever the noise cannot be mitigated, a popular solution is to place barriers (obstacles) that block the transmission path (Xiao, Li, & Zhang, 2016). However, in the mining industry, these barriers might be not that easy to implement. Despite that, effective preventive solutions are needed to solve this issue, or, at least, mitigate it.

Nonetheless, noise affects not only the workers but also the surrounding populations. Blasting and rocks crushing in surface exploitation are two operations that produce, in addition to noise, particulate matter that can propagate to high distances (Akinluyi et al., 2019; Lilic et al., 2018). Earthworks, similarly to what happens in surface mining, also involves moving soil and other materials, comprising the excavation, transport and placement of such materials, using the same type of equipment (Lee, Kim, & Hong, 2019; Xiao et al., 2016).

Thus, understanding noise as a relevant issue, the aim of this study will be to characterise the occupational exposure to noise in activities with similar problems: surface exploitation and earthworks. The systematic review will be carried out with the intent to:

1) Determine in which circumstances the exposure occurs and is most significant;

2) Identify measures to eliminate or reduce noise propagation or to mitigate its effects;

This information will later be used to help develop a preventive design in surface mining and earthworks.

2. METHODS

The Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) guidelines (Shamseer et al., 2015) were used to help draw the study outline.

[1] https://www.cdc.gov/niosh/mining/topics/HearingLossPreventionOverview.html (accessed 12/10/2020)

2.1. Eligibility criteria

2.1.1 *Study characteristics*

Participants

The research will not focus on a specific population, but adults (both women and men), as long as they were/are at the time exposed to occupational noise within the context of earthworks and extractive industry (EEI).

Type of interventions and comparators

All types of studies and any outcome related to occupational exposure to noise will be considered and further analysed, on the condition that they provide information (variables) that can be used, *a posteriori*, to help in the mining and earthworks at the design phase of a project.

Study design

Any setting of EEI (or similar work), in any country, will be considered. The research time frame will not be used as a reason for excluding any work. The information collected over a long period may allow analysing the potential evolution of the noise produced by the different equipment.

Case or official reports, research articles and any other relevant documentation concerning occupational noise exposure will be examined. Simulation models can be included wherever they provide measured field data. On the other hand, non-research articles such as conference abstract, literature reviews or even opinion articles will be excluded.

2.1.2 *Report characteristics*

The study will be conducted in two phases: 1) only English-written literature published between January 2010 and January 2021 will be searched for in peer-reviewed journals, 2) The snowballing technique (Wohlin & Claes, 2014) will be used to search for any other relevant studies. This phase will include information from conference papers, reports and articles published before 2010.

2.2. Information sources

A search of literature from January 2010 to June 2021 will be performed.

The research will include databases and journals from multidisciplinary fields: Dimensions, Directory of Open Access Journals (DOAJ), Elsevier (Science Direct), Emerald, IEEE Xplore, INSPEC, SAGE journals, Scopus, Taylor and Francis and Web of Knowledge (Current Contents and Web of Science).

2.3. Search strategy

The keywords defined to conduct the study are "occupational noise", "quarry", "open pit", "open cast", "surface mining", "open cut mining", "extractive industry", and "earthworks", where the primary key-term ("occupational noise") will be combined with every key-term, separated by the Boolean operator "AND".

Example of research expression (extracted from Scopus):

TITLE-ABS-KEY ("occupational noise" AND "quarry") AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j"))

The screening process will be recorded in a table provided in Duarte et al. (2018) with the following criteria (for the first stage): year (between 2010-2021), document type (article and article in press), source type (journals and/or trade publications), language (English).

The selected records to be included in the qualitative analysis will be screened for possible identification of new keywords and new relevant records (Wohlin & Claes, 2014).

2.4. Study records

2.4.1 Data management

The selected records will be exported from each journal or database and managed using Mendeley software, which will also serve as a tool to manage the duplicate files. A specific folder will be created for this study, and every additional record will be inserted manually.

2.4.2 Selection process

In the first phase, only the title and abstract will be assessed to determine the potential eligibility to be included in the study. Then, the articles that meet the criteria will be full-text screened to identify relevant information considering the aim of the study. Relevant data will be extracted to a pre-defined table constructed for this purpose. The exclusion of any study will be justified and recorded. Two reviewers will analyse the final table; any disagreements will be resolved by a third reviewer.

2.4.3 Data collection process

The Preferred reporting items for systematic reviews and meta-Analysis (PRISMA) (Moher et al., 2009) guidelines will be used to assist the data collection process. The flow diagram proposed by the methodology will then summarise the process.

As previously referred, it is expected that from the first selected records other relevant studies may arise. After this process, other works from the identified authors, and their respective research centres, will be sought for. This process will be repeated until no further information is found.

2.5. Data items

The data items will be organised in descriptive tables that will be built to include, but not be limited to the following information: name of the first author, year of publication, field, objective, population, sample characteristics, study design, followed standards, equipment (type and calibration), source of exposure, applied questionnaire (type and validation), main results and limitations.

2.6. Outcomes and prioritisation

The primary outcome of this research is to characterise all the variables related to occupational exposure to noise within the EEI. Later, the identified variables will be analysed under the assumption that it is possible to mitigate/correct them in the design phase of surface exploitation. To get there, the circumstances around occupational exposure will have to be examined.

2.7. Risk of bias in individual studies

The risk of bias in individual studies will be assessed by two independent reviewers, and resolved, in case of disagreement, by a third. This process will be carried out at the study level, concerning the research aim: each topic will be assessed and categorised as "low" or "high risk", considering, whenever the information is not enough a middle level, "unclear" (Higgins et al., 2011).

2.8. Data synthesis of the results

The data synthesis will be made through a narrative, including the constructed tables with the most relevant information extracted from the selected papers. All the variables will be analysed according to the study objectives.

2.9. Meta-biases

This parameter does not apply to the proposed systematic review.

2.10. Confidence in cumulative evidence

This parameter does not apply to the proposed systematic review.

2.11. Authors' contributions

Study design and development: JD, JCB, JSB

Full-text screening: JD

Data extraction: JD

Critical appraisal: JD, JCB, JSB

Data analysis and interpretation: JD, JCB, JSB

Draft of the protocol: JD

Support in the draft of the protocol: JCB, JSB

All authors read and approved the final version of the protocol.

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