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Occupational exposure to dust in road construction, earthworks and open-pit mining – a scoping review protocol

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Abstract

The exposure to respirable particulates poses a significant threat to human health globally. Several occupational activities can contribute to this problem, being open-pit mining and related activities such as road construction and earthworks some examples. This systematic review protocol outlines the main procedures to conduct a scoping review which aims to identify the most adequate variables to plan safety since the design safe. To accomplish this primary objective, some secondary objectives were defined as well. The journals and databases considered more relevant were selected (i.e. Scopus, Web of Science, and Science Direct) and a set of keywords was defined to the latter sequenced combination. The selection process of the articles is also described, in an attempt to contribute to further research on this field. Every methodology is documented and supported by the PRISMA Statement adapted to the scoping review process. All of the data treatment is detailed, including the risk of bias and attempts to manage it.

1. INTRODUCTION

Inorganic atmospheric particulates are a potential risk to human health worldwide (Baur, Sanyal, & Abraham, 2019), where more than two million deaths are estimated to occur each year due to damage to the respiratory system (Kim, Kabir, & Kabir, 2015).

Respirable particles which can reach the alveolar region of the lung represent an occupational hazard in various fields, including road construction, earth working and open-pit mining (Azarov, Trokhimchyk, & Sidelnikova, 2016; Faber, Drewnick, & Borrmann, 2015; Halterman, Sousan, & Peters, 2018). Occupational exposure to silica is one of the most frequent risk factors (Bang et al., 2015), being mining and mineral site remediation activities the most significant contributors to the particulate matter emissions (Piras, Dentoni, Massacci, & Lowndes, 2014), which also poses a significant problem in other similar activities such as road construction and earthworks (D. Li, Li, & Zhang, 2019). Dust deriving from indefinite sources (generally, more than one) are designated by fugitive dust, causing not only occupational problems, but also severe environmental issues (Sairanen, Rinne, & Selonen, 2018). However, this exposure, most of the times, does not occur to a single substance. In fact, exposures to mixed particles are widespread due to the various equipment and materials involved in the worksite (Baur et al., 2019).

One of the widely studied substances is silica. The occupational exposure to crystalline silica can be divided into two types: chronic and acute, each one leading to specific occupational diseases. Chronic occupational exposure may lead to some severe diseases such as lung cancer (Arrandale, Kalenge, & Demers, 2017; Bang et al., 2015), but also produce non-malignant effects such as pulmonary silicosis and chronic obstructive pulmonary disease (Andraos, Utembe, & Gulumian, 2018; Bang et al., 2015), chronic bronchitis (Andraos et al., 2018; Gonzalez-Garcia, Caballero, Jaramillo, & Torres-Duque, 2019), and some autoimmune diseases such as rheumatoid arthritis, scleroderma, systemic lupus erythematosus (Andraos et al., 2018). Regarding the acute occupational exposure scenario, cough and shortness of breath were shown to be caused, as well as a form of acute silicosis (pulmonary alveolar lipoproteinosis) (Andraos et al., 2018). The inhalation of other industrial dust, including magnetite, can lead to other pathologies such as diffuse interstitial fibrosis, pneumoconiosis and sarcoid-like granulomatous lesions (Xiao, Kookana, Mcclure, & Heraganahally, 2018). People with heart or lung disease are more prone to have derived health problems, including irritation of the airways, coughing or difficulty breathing, and, in extreme cases, premature death (Kim et al., 2015).

It is estimated that the dust emission is the second most common risk in the majority part of the construction industry business (W. Li & Wang, 2016). A considerable amount of dust particles are generated by activities quite similar to the ones occurring in the mining industry, such as excavation and soil loading and transporting, as well as travelling on unpaved (temporary) roads (Faber et al., 2015). However, there is a lack of knowledge regarding the mechanism of dust transport and its spread (Azarov et al., 2016), mainly from loose soils (Hassan, Kumar, & Kakosimos, 2016). Despite that, it is known that road construction and transportation generate significant environmental impacts (Verán-Leigh, Larrea-Gallegos, & Vázquez-Rowe, 2019), especially relating to air pollution (Barikayeva, Nikolenko, & Ivanova, 2018).

Regarding the open-pit mining activities, when working in an uncontrolled way lead to severe dust generation, which affects, not only the workers, but also the surroundings of the mine, due to transport and redistribution from point sources such as in loading and unloading activities, for example (Andraos et al., 2018; Baur et al., 2019; Piras et al., 2014). However, and in a similar way that has been previously stated, the mechanism of dust spread is not well characterised due to the complexity of atmospheric factors and physical removal mechanisms (Asif, Chen, & Han, 2018). In some studies it is documented the connection between exploited material and occupational disease: silicosis in gold-miners and asbestosis in asbestos miners (Baur et al., 2019), and in the coal mining, the inhalation of dust can lead to the development of coal mine dust lung disease, as well as pneumoconiosis (Halterman et al., 2018; Perret et al., 2017) and progressive massive fibrosis (Perret et al., 2017). Another remark from Xie et al. (2018) was that as the mechanisation level (in the coal mining industry improves), the more dust is produced. Studies regarding occupational exposure to respirable dust are often depicted in the production phase of a mine. However, the non-production operations should, as well, be carefully studied. A research article from Arrandale et al. (2017) in a small core processing facility operated by a gold mining company in Northern Ontario (Canada) showed that the workers in the pulp and rejects area (non-production operations) were exposed to respirable dust and silica at levels higher than what they initially expected, and that those values were similar to those reported for surface mining (production operations) in the same region.

A systematic review intended to address these issues better is going to be performed. The objective of this research is to characterise the occupational exposure to dust in activities with similar problems: road construction, earthworks, and open-pit mining. The ultimate aim will be using the encountered variables to plan safety, in the project design phase. In order to achieve that, some secondary objectives were defined:

1) To determine in which circumstances do the exposure occur;
2) To determine what is the prevalence of such occupational diseases;
3) To identify measures to eliminate or reduce dust production or to mitigate its effects.

2. METHODS

The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) was used in order to draw the scoping review protocol for this study (Tricco et al., 2018), as well as the Preferred Reporting Items for Systematic review and Meta-Analysis Protocol (PRISMA-P) checklist (Shamseer et al., 2015).

2.1. Eligibility criteria

2.1.1 *Study characteristics*

Participants

The study does not focus on a specific population: adults (both men and women), as long as they were/are at the time exposed to occupational dust within the context of road construction, earthworks and open-pit mining (REO) will be included in the study.

Type of interventions and comparators

All type of studies analysing and collecting data regarding occupational exposure to dust will be considered. Any outcome related to such exposure will also be included. All studies will be considered as long as they provide variables that can be used later in the mining design phase such as type of pavement, for example.

Study design

In the scoping review, research articles, available official reports, case reports, and other relevant documentation regarding occupational exposure to dust will be included.

Non-research articles (i.e. opinion articles, conference abstracts, literature reviews) and simulation models research will be excluded.

Any setting in any country, in any kind of REO or similar work. The study time frame will not be a reason for the exclusion of any work.

2.1.2 *Report characteristics*

The information search will be completed in, at least, two steps and the publication status will be different in the first one. In the initial step, literature from January 2015 to June 2019 will be searched, considering only texts in English, published in journals with peer review. While in the following steps all available information as conference papers, primary sources as reports, and articles published before 2015 will be considered. This snowballing technique procedure will be repeated in the new selected articles until no more relevant information is acquired (Wohlin, 2014).

2.2. Information sources

A search of literature from January 2015 to June 2019 will be performed.

The research includes some of the leading engineering databases: Web of Knowledge (Current Contents and Web of Science), Scopus, SAGE journals and Academic Search Complete. Scientific journals databases are also going to be screened from American Chemical Society, Directory of Open Access Journals (DOAJ), INSPEC, Elsevier (Science Direct), Emerald, IEEE Xplore, and Taylor and Francis. PubMed and MEDLINE (also from Web of Knowledge) are also to be covered in the health field.

2.3. Search strategy

The keywords set to conduct the study were “dust”, “dusting”, “particulate”, “powder”, “crystalline silica” which are going to be sequentially combined with “road construction”, “earthworks”, “open pit”, “open cast”, “quarry”, “mining industry”, and “extractive industry”. All of these keywords are going to be separated by the Boolean operator “AND”.

In Scopus, one of the searches will be conducted as it follows: TITLE-ABS-KEY ("dust" AND "open pit") AND (LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE, "ip")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j") OR LIMIT-TO (SRCTYPE, "d"). After registering the number of records, using the table provided in Duarte et al. (2018) the screening criteria applied will be: Year (between 2015-2019), Document type (article and article in press), Source type (journals and trade publications), Language (English).

At the end of this process in all the information sources, the selected records will be checked for possible identification of new keywords related to the subject. If found, they will be used in new search combinations with the keywords previously used (Wohlin, 2014).

2.4. Study records

2.4.1 Data management

After retrieving search results, the records will be exported from each database/journal and managed using Mendeley software. This tool will also allow the de-duplication of the results. Other considered literature will be manually entered in the folder which is going to be created for the purpose.

2.4.2 Selection process

All of the records will be assessed so to verify the relevant information regarding the aim of the research. Titles and abstracts will be screened for eligibility and data will be extracted using a standard data extraction form (Duarte et al., 2018). This process will be achieved considering some previously defined eligibility criteria. The exclusion of any article after the full-text analysis will be justified and recorded. After combining the results, any conflict will be solved by discussion between two authors; a third author will resolve any further conflicts.

2.4.3 Data collection process

To assist in the data collection process, a pre-constructed and pre-defined Excel form sheet will be used. The file will contain all of the relevant study and participant characteristics. In the cases where the reported data is insufficient or unclear, the authors will be contacted requesting the missing or clarifying data. All process will be summarised in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram (Moher et al., 2009). The respective references of the selected articles will also be checked in order to find older articles not detected in the initial survey. In this process, other works of the authors of the selected articles and other authors with relevant work in the field, as well as the respective research centres will also be verified. In this second phase will be checked al the works of the selected authors. This procedure will be repeated in the new selected articles until no more relevant information is attained.

2.5. Data items

Descriptive tables will be built with data including publication details, instrument details, as well as feasibility. The topics to be extracted will include, but not be limited to: name of the first author, year of publication, objective, number of participants, mean age, sex, study design, standards (if any), duration of the exposure, type of exposure, cause of exposure, dust collection technique, questionnaire use, questionnaire validation, reported symptoms, reported diseases.

2.6. Outcomes and prioritisation

The outcome of interest of this study is to characterise all the variables related to the occupational exposure to dust, in the REO context. If possible, to determine under what circumstances is more severe, and what are the main issues to be addressed in the project context. It will also be essential to study the prevalence of occupational diseases related to dust, regarding that this study will point the main variables to be considered when designing the mining exploitation and processes. Exposure values to dust will be collected and further analysed to determine any connections between the different considered variables.

2.7. Risk of bias in individual studies

Two independent reviewers for methodological validity will assess the selected records prior to inclusion. A third author will resolve any disagreement. The risk of bias is going to be analysed on the study level, considering the categories of greater importance in accordance with the systematic review goals, determined by the review team. Each of the topics is going to be assessed between low, high or unclear, where "unclear" means that no sufficient information is provided in order to make a judgement (Higgins et al., 2011). This bias assessment will provide additional information in the systematic review data appraisal.

2.8. Data synthesis of the results

The data synthesis will be carried through a narrative, based on the assembled data tables (with information regarding the eligible papers), considering that the outcome is to characterise the occupational exposure to dust in the REO context. The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) will be used to guide the reporting of the scoping review (Tricco et al., 2018).

2.9. Meta-biases

This parameter does not apply to the proposed review.

2.10. Confidence in cumulative evidence

This parameter does not apply to the proposed review.

2.11. Authors' contributions

Study design and development: JD, MV, JTC, JSB

Full-text screening: JD

Data extraction: JD

Critical appraisal: JD, MV, JTC, JSB

Data analysis and interpretation: JD, MV, JTC, JSB

Draft of the protocol: JD

Support in the draft of the protocol: MV, JTC, JSB

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

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